G. Chan

A SURVEY OF MARINE LIFE ON THE PT. REYES NATIONAL SEASHORE PARK

by gordon I. chan

A REPORT ON THE SURVEY OF MAJOR MARINE ORGANISMS AT THE POINT REYES NATIONAL SEASHORE PARK

by

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A B S T R A C T

A REPORT ON THE SURVEY OF MAJOR MARINE ORGANISMS AT THE POINT REYES NATIONAL SEASHORE PARK

The Point Reyes National Seashore Park is a geological peninsula rich in fauna and flora. With thousands of visitors flocking to this new park, there was a need to understand the types and densities of marine organisms within the park boundries.

The College of Marin research team was divided into subtidal and intertidal groups. Starting at the south end of the park and traversing through the northern perimeters, the team compiled the data for this survey of major marine organisms. The marine fauna and flora are magnificent in variety and numbers. Young abalone nurseries are abundant. Sea lion and seal rookeries are plentiful in all reef areas. Giant mussels are seen in the south reefs of the park. The intertidal mudflats abound with clams, with one species--Panope generosa, the geoduck--existing in significant numbers, perhaps the last vestige of a vanishing species in California.

Man has hunted many marine organisms to near extinction throughout the Pacific Coast. The Point Reyes National Park, although under the influence of marine hunters, has not been ravaged as have other areas. These populations of marine species--abalones, clams, moon snails, etc.--must be protected and preserved; perhaps these natural nurseries should be developed for replenishing other California areas where marine species populations are low in numbers. The area is blessed with marine scenic splendors and this report includes the recommendation that a National Underwater Park be established at the Bird Rock-Tomales Point area.

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ACKNOWLEDGEMENTS

In today's ecological crisis, educational institutions must stress the importance of conservation. With support from a Sea Grant project, the College of Marin untertook to use its marine technology and general education students to survey the marine organisms in the Point Reyes National Seashore Park. The students learned the use of techniques and tools which are required to research a marine environment, and hopefully these learning tasks will assist them in future employment and educational goals. Certainly the local community, park officials, and state conservation administrators will reap the major benefits of this report.

My deep appreciation is expressed for the work of the research team which consisted of these College of Marin students:

Subtidal Research Group	Intertidal Research Group
Kathryn DeMasi	Carolyn Alverson
Gregory Myers	W. J. Edick, Jr.
Mark Murray	Christie Fairchild
Edmund O'Connor	Stephan Krug
David Toponce	Marc Mitchell
Diane White	Karie O'Brien

I am always amazed at the proficiencies of college freshmen and sophomores. Their work, while below the level of graduate students, certainly is creditable; especially superb were their physical efforts in diving and intertidal transect work--these are the workers of tomorrow!

My gratitude is also extended to my colleague, Mr. Al Molina, Director of the Bolinas Marine Station, who reviewed this report. Finally, I would like to thank my typist, Miss Pamela Barone, and my wife Maxine who spent long hours in editing.

Gordon L. Chan

Principal Investigator and
Director of Marine Technology
Sea Grant Program

A REPORT ON THE SURVEY OF THE MAJOR MARINE ORGANISMS AT THE POINT REYES NATIONAL SEASHORE PARK

I. INTRODUCTION OF THE STUDY

Approximately 35 miles northwest of San Francisco lies the Point Reyes National Seashore Park. This recreational area is blended with a myriad of coastal scenes that may be unsurpassed in beauty throughout the western world. In addition to these natural environments of coastal beaches and Douglas fir forests, there are historical events which date from the landing of Sir Francis Drake in 1579 to the remnant evidence of the great 1906 earthquake movement of the San Andreas Fault.

As a contribution to the history of this vast national seashore park, this report details an initial survey of the major organisms that can be found within the park's boundries. The major purpose of this report is to form a foundational base by which park officials and other laymen can formulate conservational policies to manage and protect the park's marine fauna and flora. Thousands of visitors have already traced the many miles of trails in the park. With the advent of purchasing the remaining privately owned lands and providing additional coastal access to the multitudes of future visitors throughout the coming decades, wise decisions must now be made to insure that man will not appreciably alter the natural wonders of life in these ancient coastal habitats.

II. SAMPLING METHODS AND PROCEDURES

A. Introduction

In the first sampling survey of any wilderness area, investigators encounter many technical problems and such was the case with our survey teams. One large obstacle in our studies was establishing good underwater transect lines in the malestrom of crushing Pacific waves. Sampling techniques will be discussed as well as suggestions for future studies.

B. Sampling Method

Subtidal Sampling Techniques

Ten-meter transect lines were used, consisting of plastic rope with weights formed in a "ladder" shape. Compass transects were laid out from within the squares of the rope. These lines kept tangling with the kelp, and the waves and underwater surges made it difficult to hold to a true compass bearing.

A weighted one-square-meter wooden frame was used along a submerged compass transect line. This method was deemed the most successful. However, strong waves and currents also made the handling of this wooden square meter very difficult.

In areas of strong waves and currents, sight estimates along a compass bearing were used. Although this method was not accurate, it did provide an approximation to organism density.

In review of the various underwater sampling transects used, it would be most fortunate if future divers could exactly lay out the same location of transect lines; however, in our studies this was not possible. Therefore, all data on the sub-tidal sampling is an approximation of species density and should not be an accurate base to compare future densities in the same location. For future sampling, heavy concrete blocks should be laid out underwater, ten meters apart, and a metal one-square-meter frame can be moved along a rope stretched between the two blocks. Of course, strong winter waves can move the blocks as seen with present wave actions on large boulders.

Intertidal Sampling Techniques

Due to the convenience of the metric system, we employed the use of these measurements throughout the study. However, to facilitate the understanding of this report by lay readers we have presented the data in both metric and English inches and feet for easier reading. (One day, hopefully, we shall all be using the metric system!)

One method for the sampling of species was used in the intertidal zone. The method was as follows:

A base line along the zone 1 area of the reef was laid out between large boulders or similar permanent landmarks. With an Alvarez hand

rangefinder, the base line was divided into equal segments. A ten-square-meter rope transect ladder was laid out perpendicular to the base line on the equal segments and the ten-meter rope was moved down to the zone 4 area of the intertidal zone. Organisms within the odd or even numbered square meters were counted.

Figure 1. Intertidal transect lines

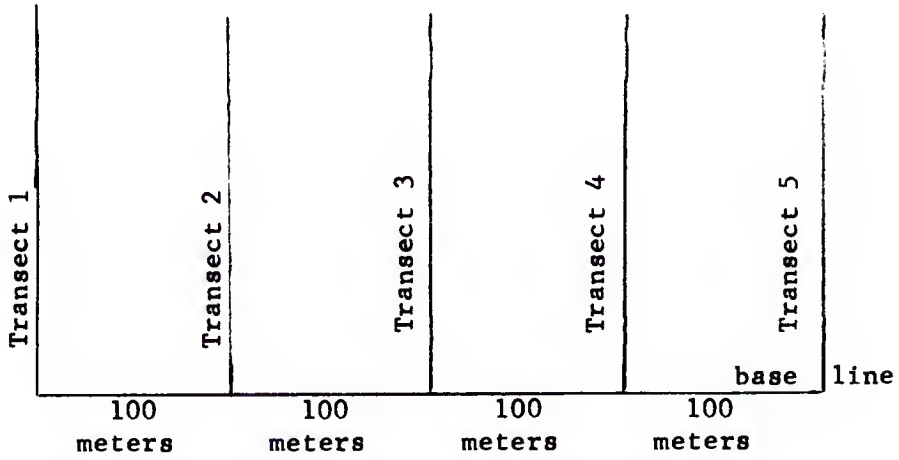


Figure 1. Intertidal transect lines

If future transect studies are made to restudy these same intertidal samples, there would, in my opinion be a 75 per cent chance of repeatable transect accuracy! The exact details of all sub-tidal and intertidal transect measurements may be found in the College of Marin's Bolinas Marine Station Library, with the individual papers bound under the title of "Distribution Studies of Invertebrates in the Point Reyes National Seashore Park, 1970."

C. Statistical Formulae

Terminology

Sample refers to the group of individuals under study. The sample is but a representative "specimen" or portion, randomly selected, of a much larger total group called the population.

Population as noted above refers to the total aggregation of a species of individuals in a statistical study. In this report, population statistics are based on data collected from the sample.

Mean refers to the average of all measurements.

Sample mean, $\bar{X} = \frac{\sum x_i}{n}$ = $\frac{\text{sum of all measurements } (x_1 + x_2 \ldots + x_n)}{\text{Number in the sample } (n)}$

Variance, $s^2 = \frac{n \sum x_i^2 - (\sum x_i)^2}{n(n-1)}$

Standard Deviation, $s = \sqrt{\text{variance}}$

Formulae

Data from the sample may be interpreted in terms of the population by use of statistical formulae and tables, using Z table for $n \geq 30$, and t for $n < 30$.

For Population Mean

The 95% Confidence Interval is used consistently in this paper to determine the interval within which we may expect the population mean to be. If, on the basis of repeated sampling, many 95% confidence intervals for μ (Mu, the population mean) are set up, then approximately 95% of these confidence intervals will actually contain the true mean, μ.

Confidence Intervals*

For sample size less than 30: $\alpha = .05$

$$P\left(\bar{X} - t_{\frac{\alpha}{2},n-1} \frac{s}{\sqrt{n}} \leq \mu \leq \bar{X} + t_{\frac{\alpha}{2},n-1} \frac{s}{\sqrt{n}}\right) = 1 - \alpha$$

For sample size equal to or greater than 30: $\alpha = .05$

$$P\left(\bar{X} - Z_{\frac{\alpha}{2}} \frac{s}{\sqrt{n}} \leq \mu \leq \bar{X} + Z_{\frac{\alpha}{2}} \frac{s}{\sqrt{n}}\right) = 1 - \alpha$$

*Interpretation found in most standard statistical books.

Sampling Sites

In Figure 2 the map indicates the general area of the selected sampling sites. These sites were chosen on the predicted basis that these would be the areas most heavily and frequently visited by people. These locations have outstanding marine habitats and will generally be accessible to the hikers.

Starting from the south portion of the Point Reyes National Seashore Park, these locations are:

South Double Point
Sculpture Beach Reef

Limantour Estero Mudflats
Drakes Estero mudflats and Reef
Drakes Beach
Chimney Rock Reefs
Split Rock Reefs
Big Pipe Reef
Bird Rock Reef

Included in this report are discussions about the major organisms found in Pt. Reyes Beach Abbotts Lagoon, Pelican Pt., and Hearts Desire Beach.

From Appendix I, there will be a report on average size and growth layers of the red abalone, Haliotis rufescens. The size, which indicates shell length, was measured with calipers and is reported to the nearest 1/8 inch. The growth layers are mantle layers theorized by the author to be laid down each year. During the first two years of growth the abalone grows to about three inches and the mantle layers are not seen. Thus the reported layer of 16 indicates the term "at least" 16 years old. Finally, on many shells, growth layers are not distinguishable because of the heavy layering of the muscle scar tissue.

In review then, this report is an estimate of major marine organisms in specific areas of the Point Reyes National Seashore Park. These estimates will hopefully form the base for some decisions concerning the management of marine species. Certainly, this initial study should spur other future investigators to study in greater detail and accuracy the diversity of marine life found within the Park boundaries.

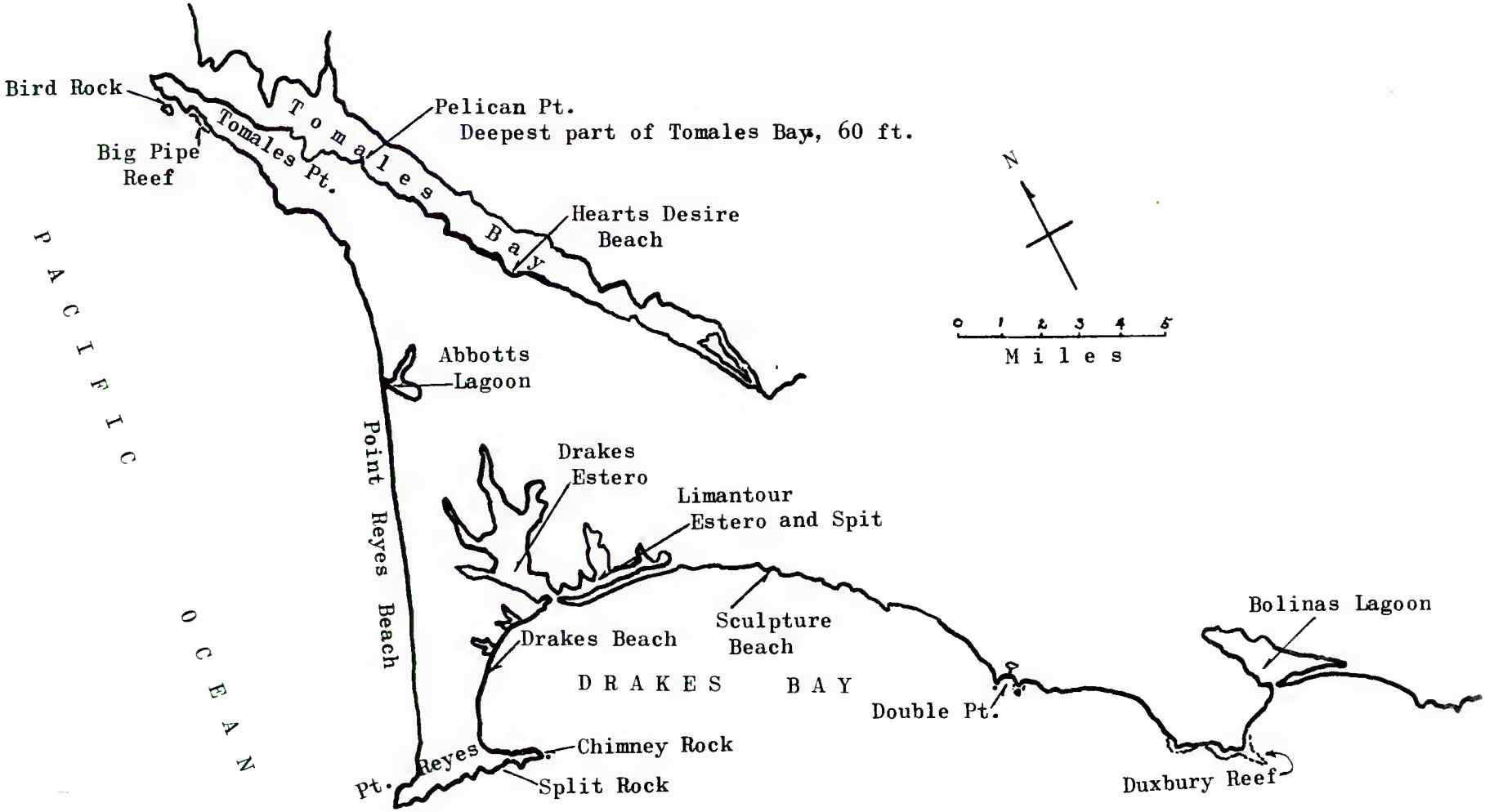


Fig. 2. Sampling Areas in the Point Reyes National Seashore Park

III. PRESENTATION AND INTERPRETATION OF DATA

The presentation and interpretation of data will begin with the southern range of the Point Reyes National Seashore Park and will end in the northern portions of the park. To actually gain the overall perpective of the entire Point Reyes Peninsula, the interested reader should consult the author's work on Duxbury Reef and Bolinas Lagoon (see bibliography)

A. DOUBLE POINT

Introduction to the Area

This horseshoe shaped headland is made of hard Monterey shale with Pelican Lake set in between the north and south points. There is a sea stack off each eroding headland, with the south stack very close to the intertidal reef, see Figure 3, diagram A sketch. The north headland with an elevation of about 400 feet was an anti-aircraft gun site during World War II and the concrete bunkers are still very evident. Bats inhabit these bunker rooms and the author was scratched on the head by one of these erratic flying mammals during a visit in the summer of 1969.

In Figure 3, diagram B, the sketch illustrates the location of year-around sea lion rookery. Census of the numbers of the California Sea Lion, Zalophus californicus, was 42 on December 6, 1962, and 30 on July 2, 1965. In addition, there were about 10 Harbor Seals, Phoca vitulina, mixed into these herds on both census counts. On May 5, 1959, I descended to the South Point Reef by way of the South Ridge Trail (Fig. 3,B) and observed the herd with no disturbance to their beach habitats. However, whenever we descended to the Double Pt. Cove beach by way of the Pelican Lake drainage canyon, the herd always hastily moved into the ocean. My students and I all agree that visitors should be prevented from descending to this beach area by way of the Pelican Lake canyon for fear that frequent visitations will permanently drive away this sea lion herd.

While this paper is not a geological report, one has to admire the outstanding faulting and folds within the beautiful stratification seen at the tip of the South Point.

Subtidal Data and Interpretations, Double Point

June 23, 1970, overcast - fog
-1.1 Tide at 9:30 a.m. (at the Golden Gate)
Water temperature, 56 degrees F
Underwater visibility, 2.5 feet
Ocean condition, 3 to 5 foot waves

Sampling method: Rope transect, 10 meters long at Sample No. 1, a large sea stack rock. (Fig.3,B)
Compass transect, 10 meters long at Sample No. 2, at another sea stack rock. There were five-foot waves hitting on the divers at Sample site No.2 which made the transects counts very difficult.

Fig. 3 DOUBLE PT. AREA

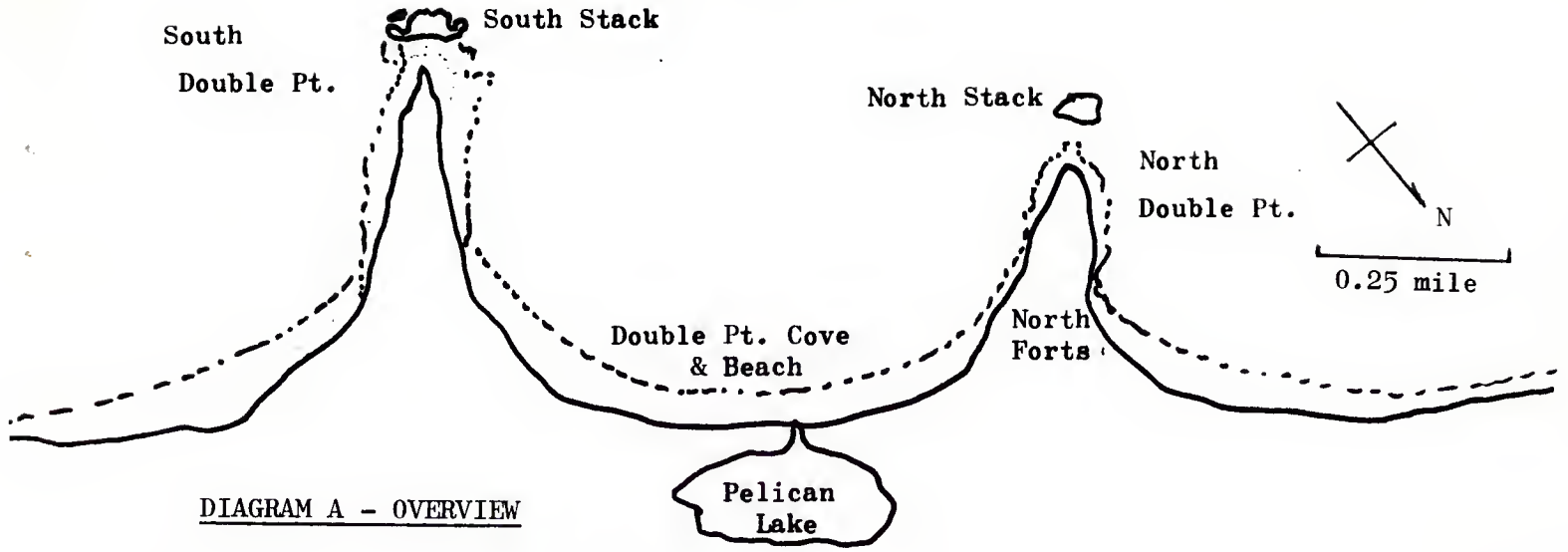


DIAGRAM A - OVERVIEW

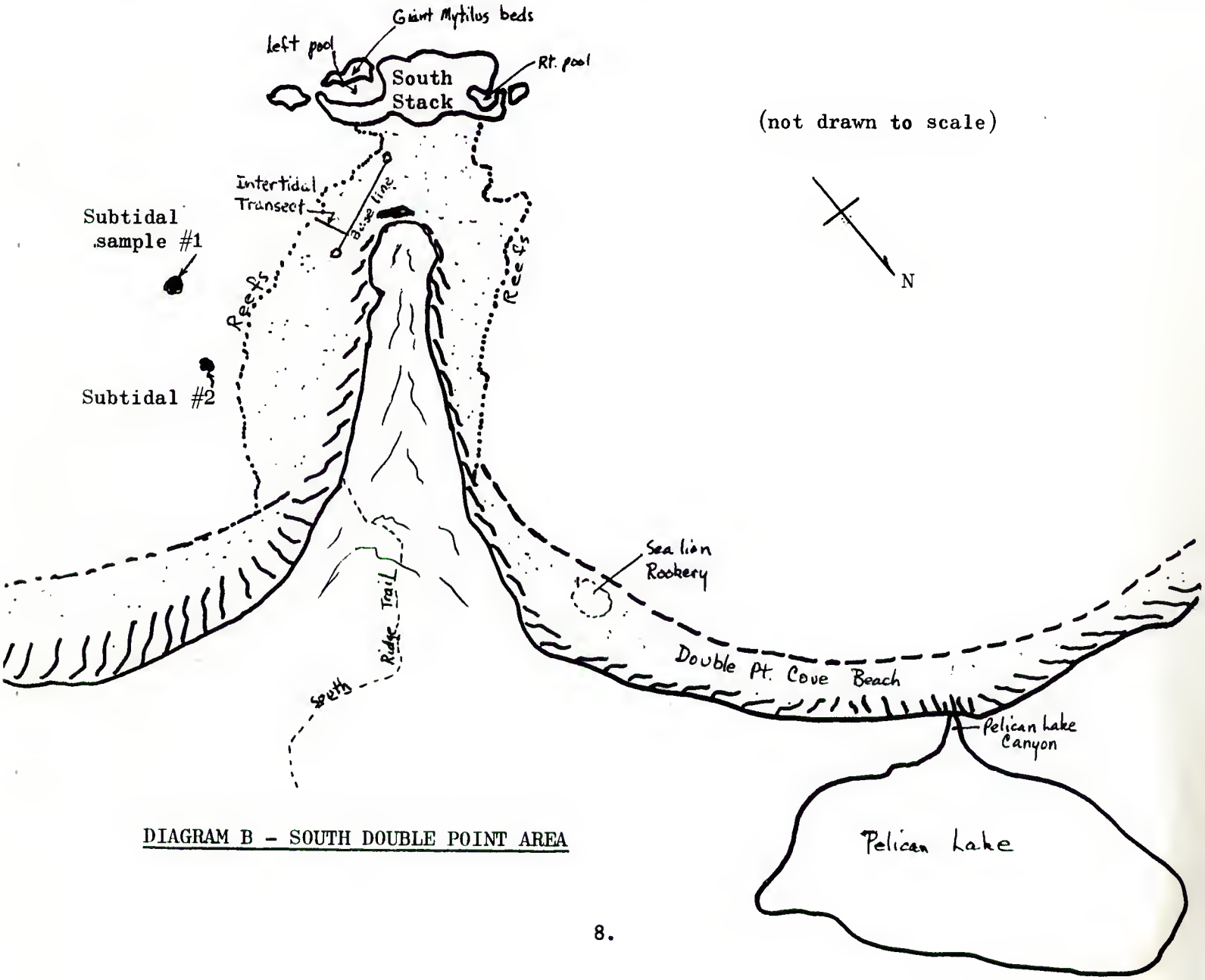


DIAGRAM B - SOUTH DOUBLE POINT AREA

Fig. 4. Subtidal Data on Haliotis rufescens, Red Abalone

	Sample Site No. 1	Sample Site No. 2
No. of transects	8	8
No. of square-meter counts per transect	5	5
Total number in the Sample	40	40
Sample mean, $\overline{X}$	1.5 per transect count of 5	1.25 per transect count of 5 square meters

Average red abalone size, 9½ inches.
Average mantle growth layer, 26.

The estimation on the number of red abalone, Haliotis rufescens is one or two abalones per total count of five square meters. The divers were subjected to strong five-foot waves with 2 to 3 feet visibility. Sampling conditions were not the best. The average red abalone measured 9-4/8 inches, with 26 growth layers (See Appendix I) and the shells were extremely deep; one shell was 4-3/8 inches in depth (a Pacific Coast record). The growth layers from the inner mantle tissue have been used as an age determinant by the author. This age estimate varies greatly from area to area. The author has observed a hermit living at this South Point, 1955-1959, and in 1960 his shack burned down revealing a pile of abalone shells numbering 550. It is presumed that he, and other visitors from the Bolema Club and Lake Ranch area have depleted the intertidal reef area of the red abalone.

Subtidally a small, older population of abalones still remains with no signs of juvenile nursery. At each sample site, the seven divers had turned over rocks to look for juvenile abalones (½ inches to three inches), but with no success. These subtidal abalones had shells that were pitted and corroded by the yellow boring sponge, Ciona celata. With the average of 26 growth layers, these abalones may be among the oldest abalones on our Marin County shores. The primary food of the abalone appears to be the blades from the stalked kelp, Pterogophora californica. The abalones were generally on the sides of rocks in 20 feet of water, and towards shore they were inhabiting in crevices. Strong wave and current actions, along with turbid sediment waters, causing poor visibility,will probably keep divers from depleting this South Double Point population of red abalones.

Although a census was not taken here of sea urchins, the divers estimated that the population of purple and red urchins was significant from 8 to 20 feet of water at the two study sites.

Intertidal Data and Interpretations, Double Point

The Double Point intertidal zone contained a rich diversity of marine life. Since very few visitors can reach this reef, the amount of human collecting appeared to be negligible. The only apparent shortcoming is that no

red abalones were observed during this -1.1 tide --supporting the contentions of other marine biologists who have visited this area that there is a lack of intertidal abalones.

A base line of 175 yards was laid out between two large intertidal rocks and the line was subdivided into equal portions of 17.5 yards, Fig.3-B. The second divisional mark was randomly selected and a perpendicular transect line was laid out towards the ocean. Using the 10-meter rope-ladder, and counting the even numbered squares, the divers made counts in seven square meters. Only the significant macro marine organisms were counted, omitting the large multitudes of micro and small organisms that abound on this reef.

Figure 5. Significant Intertidal Organisms at Double Point

Species	Sample mean, X/m^2
Anthopleura xanthogrammica, giant green sea anemone	5.0
Balanus glandula, acorn barnacle	74.0
Cancer antennarius, Rock crab	1.4
Pagurus samuelis, hermit crab	2.9
Petrolisthes cinctipes, porcelain crab	4.7
Mopalia mucosa, chiton	2.0
Littorina planaxis, Littorine snail	1.5
Acmaea digitalis, limpet	1.3
Leptasterias equalis, small sea star	1.2
Pisaster ochraceous, purple sea star	1.0
Amphipholis pugettana, brittle star	2.0

The sample mean of barnacles, Balanus glandula, indicated that the study transects were dominated by these small crustaceans, Figure 5. The presence of the purple sea star, Pisaster ochraceous, and the red rock crab, Cancer antennarius, generally indicates intertidal areas where few humans visit. At Duxbury Reef, these two marine species were the most frequently collected organisms picked up by reef visitors.

The sample transects did not have any of the California mussel, Mytilus californianus, as these are generally higher in the tidal zones. However, in the south sea stack area, Figure 3-B, is located one of the most outstanding beds of these mussels that I have seen on the Pacific Coast. These intertidal mussels are large in size. On January 3, 1962, we measured 30 mussels and the average size was 7¼ inches with the largest at 8½ inches (the latter

being about an 1/8 of an inch from the Pacific Coast record). Generally, mussels of this size are usually picked up by mussel hunters and I feel that unless these are protected, individuals from nearby towns will deplete these old mollusks. From my studies of mussel successions on Duxbury Reef, I estimate these large Double Point mussels to be 30-40 years old. There is no California State law which limits the taking of mussels. All one needs is a fishing license and he can gather and carry out as many mussels as he desires.

In review, Double Point presents outstanding coastal scenery, as well as unique fresh water lakes, streams, and vegatation, making this location a future highlight in the Point Reyes Park. The most important habitats to conserve in this area would be the sea lion-seal rookery, old abalone beds, and the giant mussel beds. This reef has always been a great attraction for those desiring to photograph marine life of all forms.

B. SCULPTURE BEACH

Located between Bear Valley Trail and Limantour Spit is Sculpture Beach. This beach is easily reached by trail and the coarse sand beach is flanked on both sides by jutting intertidal shale reefs, Ten to fifty yards offshore are large beds of the short kelp, Laminaria Andersonii and Pteroygophora californica. Further out, about 150 yards are the patches of the bull kelp, Nereocystis luetkeana, and California kelp, Macrocystis integrifolia, Figure 7. The stipe length of the latter kelp was about 50 feet and this kelp bed could support a small herd of sea otters. A close monitoring of the feeding habits of the sea otters here would provide valuable data for determining the feasibility of transplantating this mammal to other north coast spots.

Subtidal Data and Interpretations, Sculpture Beach

July 8, 1970, clear, some high clouds
Tide 0.2 at 9:18 a.m.
Ocean conditions -- flat
Ocean temperature, 52 degrees F
Water visibility, 10-15 feet

Only two abalones were observed, one of which was taken, a female, 8½ inches long with about 14 growth layers. Both abalones were found in crevices, indicating the presence of man's hunting activity which, in my opinion, drives the organisms back into protective rock crevices. Park rangers, past and present, have repeated the stories of large populations of abalones in these areas, but none were to be found by our diving teams. Perhaps they are elsewhere in the area, or these animals have already been removed. No nurseries were found even though there were ideal provisions of food (kelp) and water conditions. In general, I suspect that man has visited these areas many times, especially by boat since this area has fairly calm waters -- the ocean conditions are favorable because of the protection by the Pt. Reyes Headlands across Drakes Bay.

One square-meter patch of purple sea urchins, Strongylocentrotus purpuratus, under 8 feet of water yielded a count of 127 urchins! Both the purple and red urchins abound in dense patches around each underwater reef area.

The diving conditions were enhanced by the many underwater reefs running parallel to the beach, see Figure 6. The cliff-ridge at E was about 10 feet high, and in about 40 feet of water some of the large white-sea anemones, Metridium senile, appeared to be about one foot long. Furthermore, tunicates and marine worms were abundant, giving much color to the scene for the underwater diver. Lastly, there were many fish, the Black Rock fish, Sebastodes melanops, and the Lincod, Ophiodon elongatus. This area should be a popular spot for underwater photography.

Intertidal Data and Interpretations, Sculpture Beach

With the 10-meter transect ladder, 15 square-meter counts were taken, see Figure 6, spanning an area from the vertical intertidal zone 2 to zone 3. Significant major organisms counted are listed in Fig. 7.

Figure 6. SCULPTURE BEACH

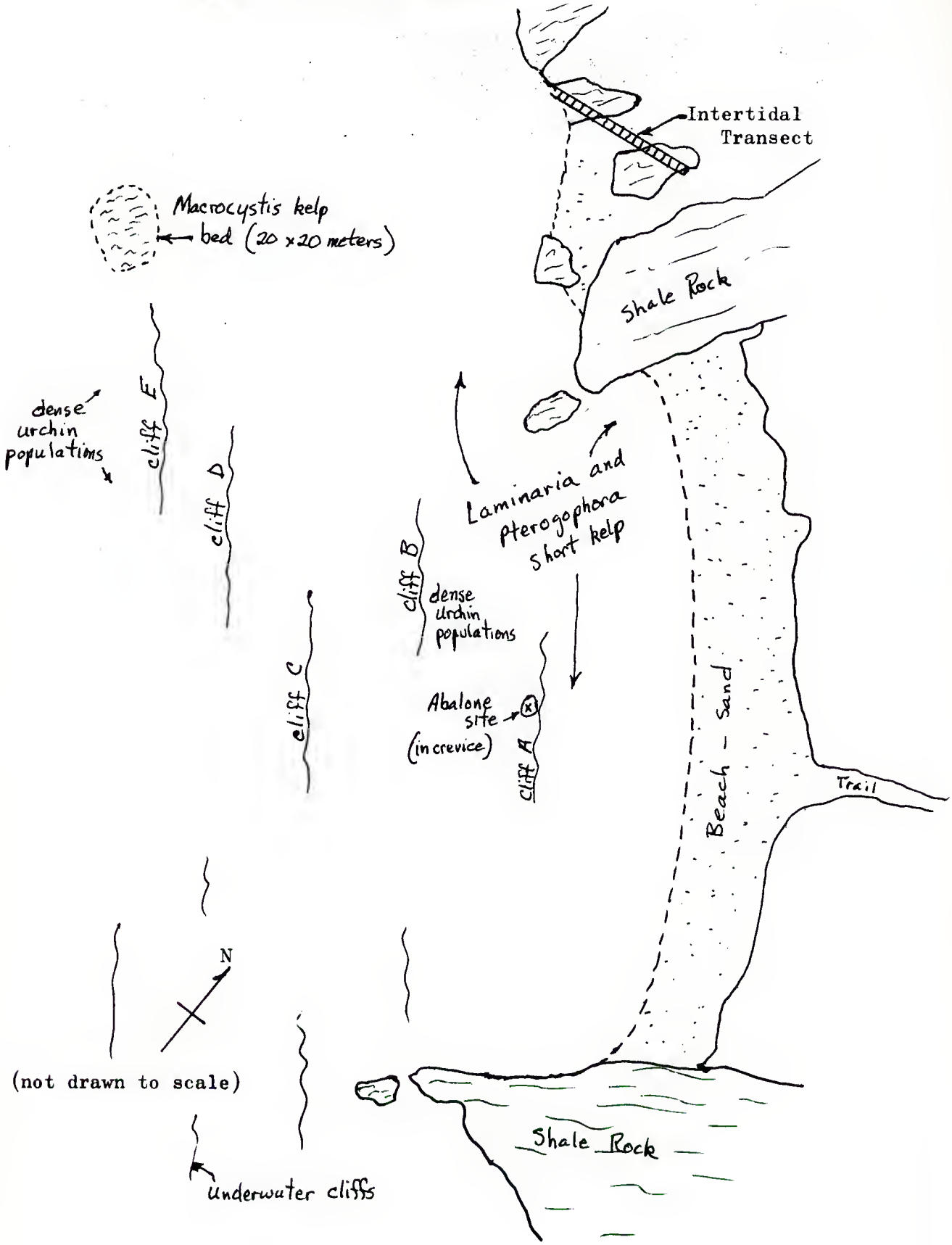


Figure 7. Major Intertidal Organisms at Sculpture Beach

Species	Sample mean $\bar{X}/m^2$	Significant 95% Confidence Interval
Anthopleura xanthogrammica, sea anemone	1.9	----
Anthopleura elegantissima, sea anemone	50.7	----
Pagurus samuelis, Hermit crab	1.6	$.1 \leq H \leq 5.0$
Littorina planaxis, Littorine snail	24.0	----
Mopalia lignosa, chiton	1.5	----
Acmaea scabra, limpet	182.0	----
Acmaea digitalis, limpet	166.0	----
Mytilus californianus, mussel	743.0	$333.6 \leq H \leq 1452.6$

Some confidence intervals were not computed, thus accounting for the blanks, while others had a minus number which made the intervals not significant.

In general, the most dominant organism at this reef was the mussel, Mytilus californianus, Figure 7. The average size of the mussels in the transect bed was estimated to be about four inches. Large size of mussel beds generally indicates the absence of human predators.

C. DRAKES ESTERO STUDY AREAS

Of all the marine lagoons in California, I feel that Drakes Estero and surrounding areas are the most primitive and relatively undisturbed estuary when compared to other California lagoons visited by man. The surrounding private lands and lack of a major access road have probably been the main factors contributing to the overall pristine nature of this marine environment.

The Drakes Estero study areas are divided into four locations, Figure 8. These are:

1. Limantour Spit Mudflats
2. Drakes Estero Mudflats
3. Drakes Estero Rocky Intertidal
4. Drakes Beach

The information presented for each location is, as previously stated, a summary of several detailed reports which are filed at the Bolinas Marine Station. The map, Figure 8, represents an overview of these locations and for more exact specifications, the investigator should consult the individual student papers.

1. Limantour Spit Mudflats

Data and Interpretations

July 2, 1970
-1.1 Tide at 5:54 a.m.
Clear skies
Water temperature, 54 degrees F

Significant Species	$\bar{X}/m^2$	Significant 95% C.I.
Phoronopsis viridis, "string worm"	581.	$160.9 \leq H \leq 1001.0$
Gemma gemma, small clam	3.21	$.3 \leq H \leq 6.1$
Upobebia pugettensis, blue ghost shrimp	3.4	$1.9 \leq H \leq 4.9$

Three transects, 20 square-meter counts

The species list, Appendix V, indicates the types of organisms found in this area. The "string worm," Phoronopsis viridis, appears to be the most numerous animal -- great beds of these animals exist throughout the whole Drakes Estero areas.

Since clam hunters find access to this mudflats by way of the Balboa Road, we expect the population of the gaper or horseneck clam, Tresus nuttallii to be few in numbers. Of the 20 square meter blocks sampled, only 11 horseneck siphons were counted along the base line transects, Figure 8. Some clam hunters have stated that these mudflats contain many horsenecks. In visiting this area over a span of 10 years, I have observed less and less horseneck clams. Contrary to the claim of an alleged dense clam population, my conclusion is that this area, once populated, now contains only a sparse population.

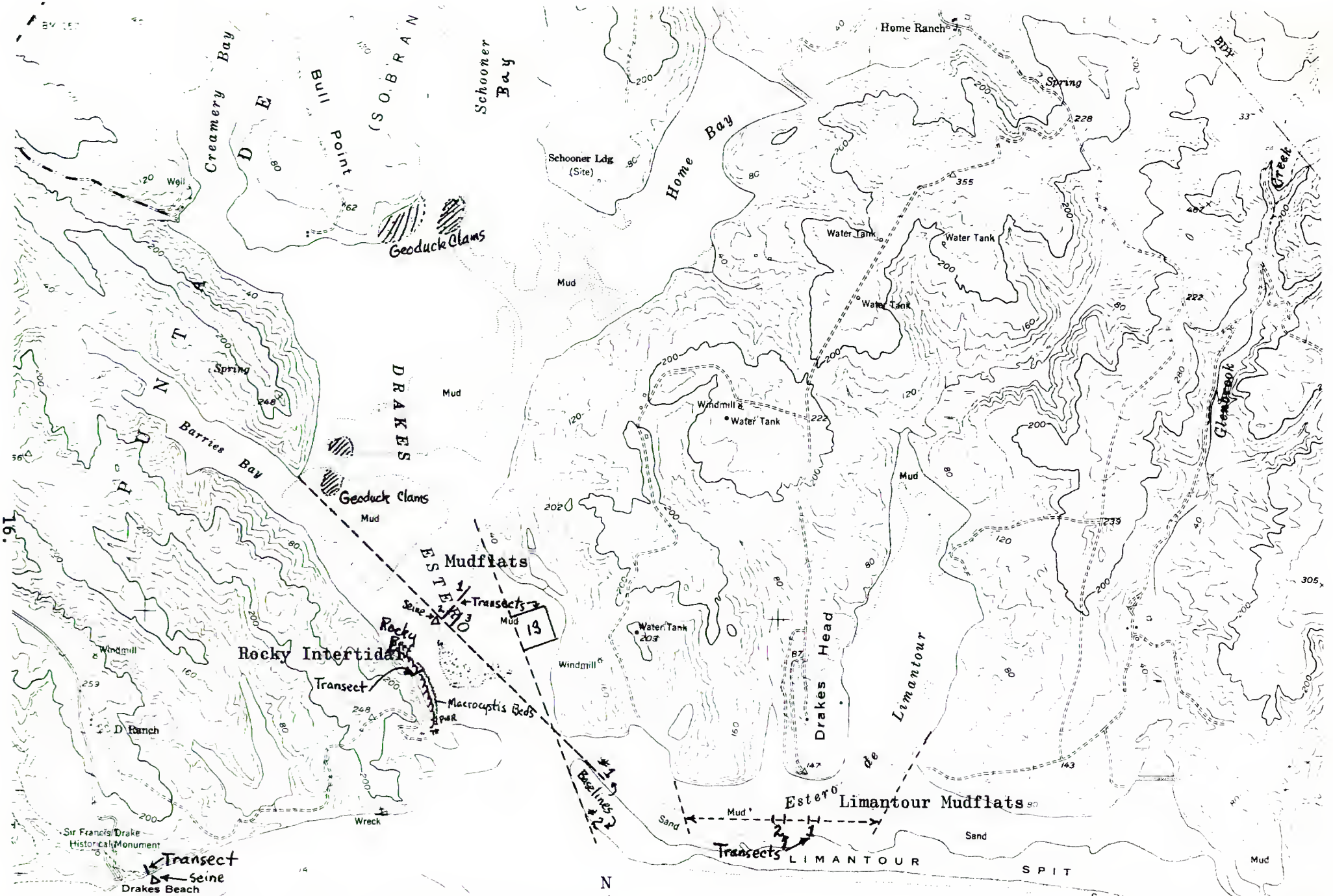


Fig. 8. DRAKES ESTERO STUDY AREAS

Another organism that we looked at with some care was the giant moon snail, Polinices lewisi. Snail hunters have reportedly taken these home to eat, and our students surveyed the total length of the base line, Figure 8, and counted 142 of these snails, 25 of which had protective egg cases around the shell. Bolinas Lagoon no longer contains a population of moon snails, probably due to a combination of pollution and human predation. These moon snails need to be given protection from the increasing number of visitors to these mudflats.

The last significant organism that will be mentioned here are the varieties of sea slugs that inhabit the mudflats and the eel grass, Zostera marina, beds, see Appendix V for the species. The Zostera beds must be maintained and protected from pollution because they form a habitat for many species of fish as well as mollusks, such as the sea slugs. On December 28, 1967, my students and I observed two large species of sea slugs, Triopha grandis and Melibe leonina, on these Limantour Zostera beds. Such observations of these large sea slugs (about 4 inches in length) is a rare treat. We have not observed these animals before or since that date.

2. Drakes Estero Mudflats

Data and Interpretations

June 30, 1970
Tide, -0.8 at 4:30 a.m.
Water temperature, 52 degrees F

July 1, 1970
Tide, -1.1 at 5:12 a.m.
Water temperature, 52 degrees

Two base lines were laid out for each of the above days. From base line 1, three transects were taken, and from base line 2, 13 transects were laid, giving a total of 78 square meter counts, Figure 8.

Significant Species	$\bar{X}/m^2$	Significant 95% C.I.
Phoronopsis viridis	3650.0	$1037.3 \leq H \leq 6267.7$
Axiothella rubrocincta	26.5	$21.6 \leq H \leq 31.4$
Tresus nuttallii	.5	$.2 \leq H \leq .6$

The species in greatest density, by far, was the "string worm," Phoronopsis viridis. In the sampled area, a staggering average of 3,650 animals per square meter was determined. The counting method consisted of determining the average numbers in one square decimeter and then multiplying this number by 100 to obtain the numbers within one square meter.

Concerning clams, in this Drakes Estero mudflat area, we found more horseneck clams, Tresus nuttallii, than at the Limantour Estero mudflats. Although no counts were made at this time, the geoduck clam

beds, Panope generosa, are located near Barries Bay and Schooner Bay, Figure 8. These giant clams bore down about 4 feet below the surface mud. On November 7, 1967, I estimated the counts in these locations to be about 3 per square meter. From my visitation to other lagoons, I conclude this population of Panope generosa may represent the remnant of a vanishing species in California. In the Hood Canal, Puget Sound area of Washington, there is an attempt to replenish and farm these clams. If this attempt is successful, perhaps the State of California could undertake a similar task to farm these mollusks for California sportsmen. At any rate, Drakes Estero is still fortunate to have some of these large clams in its mudflats.

3. Drakes Estero Rocky Intertidal

Data and Interpretations

July 1, 1970
Tide -1.1 at 5:12 a.m.
Water temperature, 52 degrees F
Clear weather

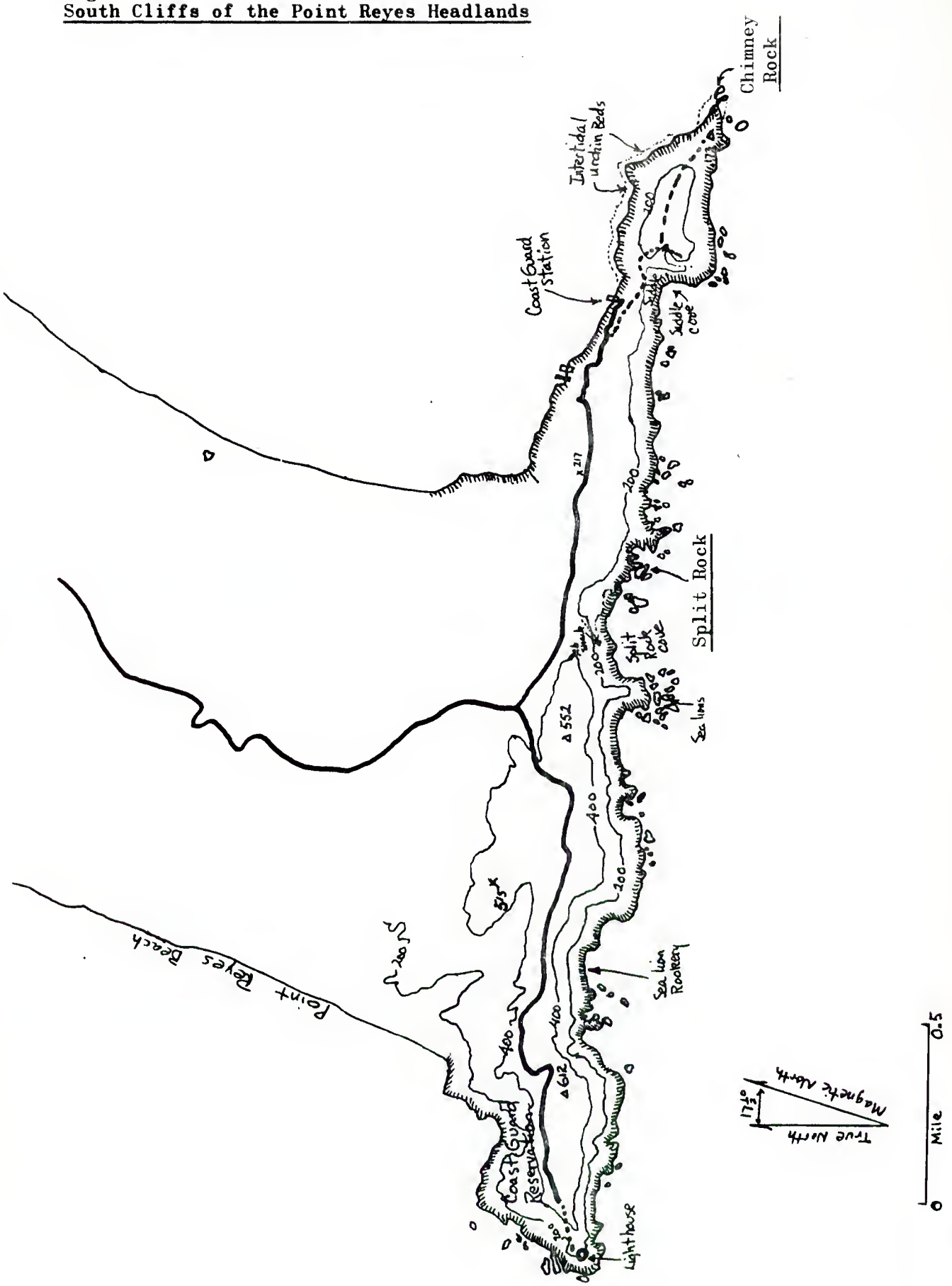
One transect, 7 square-meter counts

Significant Species	$\bar{X}/m^2$
Anthopleura elegantissima, sea anemone	11.0
Acmaea digitalis, limpet	1.57
Thais emarginata, snail	6.86
Hemigrapsus nudas, purple shore crab	11.14
Petrolithes cinctipes, porcelain crab	34.86
Pachygrapsus crassipes, purple shore crab	6.43
Pisaster ochraceous, purple starfish	1.1

Crabs seem to be the most numerous in this protected rocky intertidal area. Like most sheltered reefs, the area lacks an abundance of sponges, hydroids, and turnicates. The occurrence of a large bed of the kelp, Macrocystis integrifolia, surprised us, but the large amount of ocean water flushing in and out of the estero probably accounts for the presence of this kelp bed. Fish of all forms were found hiding in the kelp. Although no quantitative studies were made of fish, the estero is known for its large diversity of sharks and rays. We did catch two juvenile ling cods in a seine, indicating that these estero waters, like Bolinas Lagoon, may be a nursery for many game fish.

Finally, the plankton tows here as well as in the Drakes Bay Beach portion indicated a high density of the diatom Cosinodiscus spp. One sample indicated a count of about 4000 per cubic centimeter. Such diatoms are known to be choice planktonic foods for clams and oysters.

Figure 9.
South Cliffs of the Point Reyes Headlands



4. Drakes Beach

Data and Interpretations

June 25, 1970
Tide, 0.2 at 11:00 a.m.
Water temperature, 52 degrees F
Overcast
Surf waves, 2-3 feet

Seine, 50 feet, ½ inch mesh, bag type. Three seining attempts yielded one crab, two perch and one flatfish. A combination of surf, currents, the large mesh openings, and poor techniques probably attributed to the low yield.

The most significant find in the intertidal sands near the Drakes Beach entrance, Figure 8, was the red bloodworm, Euzonus mucronata. These worms occupied a stretch of beach near the zone 2 intertidal area, measuring about 30 yards by 10 yards. One square decimeter sample contained about 1500 worms. These worms engulf the organic rich sands, straining the nutrients from the surface of sand grains. This is the only beach in Marin County that contains these unique worms. Consult the species list, Appendix VII, for other animals which inhabit the Drakes Beach area.

D. CHIMNEY ROCK, POINT REYES HEADLANDS

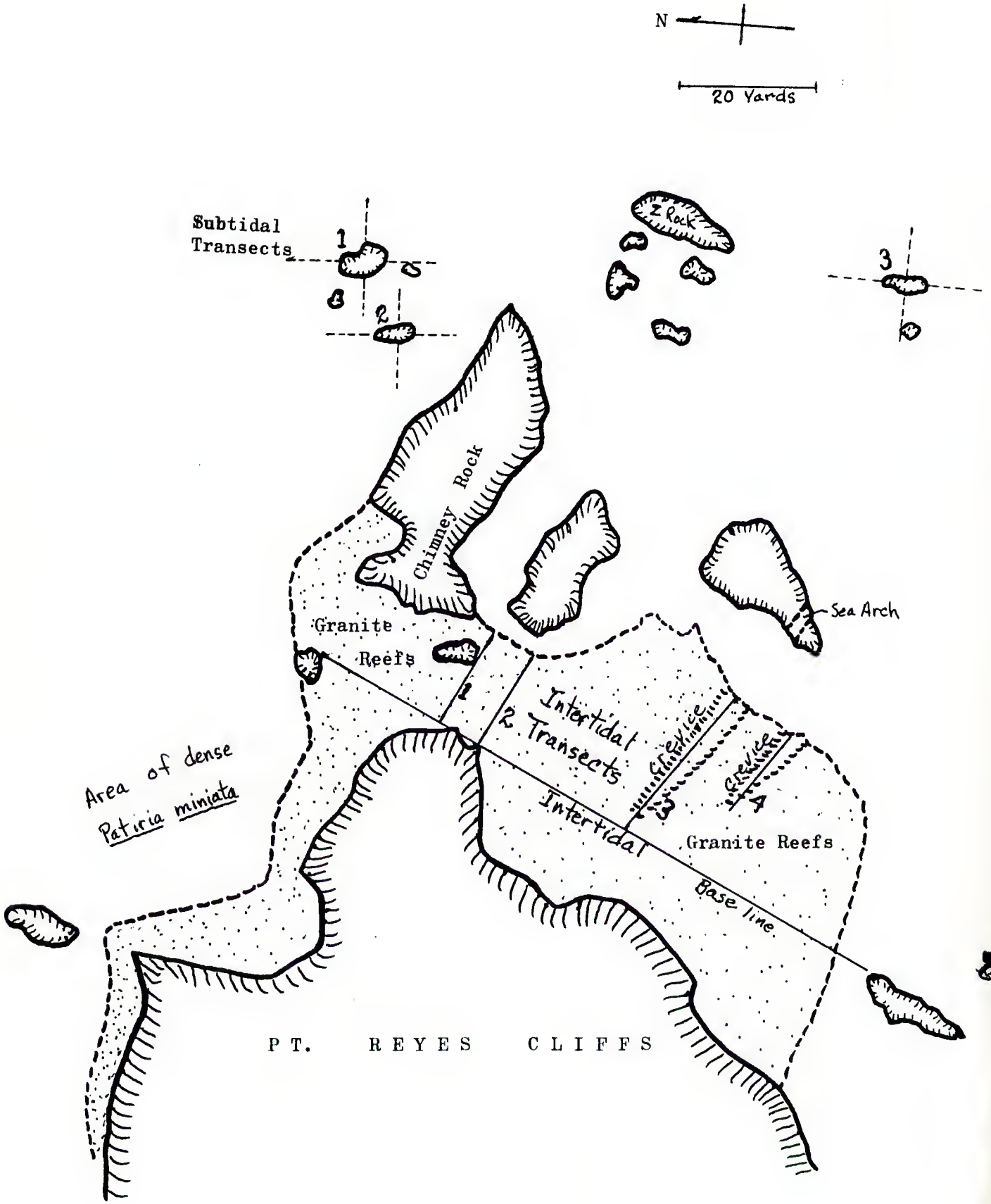
Chimney Rock is the outermost sea stack among the steep granite cliffs of the eastern part of the Pt. Reyes Headlands, Figure 9. Surrounding the sheer cliffs of this area is a granitic bouldered reef that bridges the Chimney Rock seastack to the peninsula. Since the area is nearly void of human visitors, the tide pools abound with diverse marine life. These virgin reefs will be a strong public attraction, but the access to these reefs from the high crumbly cliffs will pose a threat to the average visitor.

July 7, 1970
Tide, -0.2 at 8:45 a.m.
Overcast, fog
Water temperature, 52 degrees F
Air temperature, 50 degrees F
Ocean surf waves, 3-5 feet, strong currents
Water visibility, 1 foot in close, 10 feet beyond the breaker line.

Subtidal Data and Interpretations, Chimney Rock

Three surf rocks surrounding Chimney Rock were chosen as the base markers for the compass bearings of 10 meters each, Figure 10. At each transect site, the four transects revealed the following counts for the red abalone Haliotis rufescens.

Figure 10. CHIMNEY ROCK AREA - Subtidal and Intertidal Transects



Subtidal

Rock Site	Abalones $\bar{X}/m^2$	95% C.I.
No. 1	1.9	$1.2 \leq M \leq 2.5$
No. 2	1.5	$.9 \leq M \leq 2.0$
No. 3	1.3	$1.0 \leq M \leq 2.0$

Average abalone size, 5-7/8 inches
Average abalone growth layers, 10

There is a significant density of abalones at the base of these wash rocks. An estimated average size of these abalones is about 7½ inches. Nearby at Rock site 2, Figure 10, our divers, Ed O'Connor and Dave Toponce, counted 40 abalones clustered at the base of the rock in about eight feet of water. The large number of juvenile abalones, 1 to 5 inches, indicates a good nursery area.

At Rock site No. 3, a census count of sea urchins, Strongylocentrotus spp., revealed a mean of 2.6 per square meter.

Surrounding the total subtidal rock area was a dense growth of the surfgrass, Phyllospadix sp., some leaves stretching out to six feet. Finally, on the northeast side of Chimney Rock, a large subtidal population of the bat starfish, Patiria miniata, was observed. Together with the many tunicates and sea cucumbers, this is an outstanding and colorful subtidal area.

Intertidal Data and Interpretations, Chimney Rock

With the Alvarez rangefinder, a baseline was established and four laddered transects were laid down, and 33 square-meter counts were recorded.

Figure 11. Major Chimney Rock Species	$\bar{X}/m^2$	Significant 95% Conf. Intervals	
Pagurus samuelis, hermit crab	1.4	.35	.2.5
Pycnogonum stearnsi, sea spider	.8	.4	1.2
Petrolisthes cinctipes, porcelain crab	1.7	.4	3.0
Balanus glandula, acorn barnacle	105.6	47.5	163.9
Hemigrapsus nudas, purple shore crab	.5	.2	.9
Haliotis rufescens, red abalone	.6	.4	.9
Littorina planaxis, littorine snail	78.5	46.8	110.2
Tegula funebralis, black turban snail	4.6	2.9	6.3
Cryptochiton stelleri, gum boot chiton	.5	------	
Thais emarginata, rock snail	2.3	.6	4.1

	$\bar{X}/m^2$	Significant 95% Conf. Intervals	
Patiria miniata, bat starfish	.3	.2	.4
Leptasterias sp., small starfish	1.3	.9	1.7
Strongylocentrotus purpuratus, sea urchin	1.6	.8	2.4
Pycnopodia helianthoides, sunstar	.2	.1	.2
Pisaster ochraceous, purple starfish	.3	.2	.4

In Figure 11, the intertidal red abalone was a significant find. All 20 of the red abalones counted were between 2 and 7 inches in length, again supporting the observation that this area is a nursery for this species. Together with the subtidal abalone census, the average-sized abalone in this area was 5-7/8 inches. The average growth layers of 8 indicates a fairly young population of abalones.

Other significant organisms found intertidally here but not at other more accessible reef were the Gumboot chiton, Crytochiton stelleri, which is the largest chiton in the west, and the sunstar, Pycnopodia helianthoides. Like the divers, the intertidal crew acclaimed this reef to be very abundant with marine life.

E. SPLIT ROCK COVE, POINT REYES HEADLANDS

Split Rock Cove is a protected cove surrounded by granitic rocks. The Split Rock Trail drops from about 400 feet to sea level, Figure 12. Visitors will find the descent to re relatively easy, but the walk back up is a heart-pounding experience--especially when one is loaded down with diving aparatus. At left of the cove is a gigantic granitic rock that has sheared off from the peninsula, hence the name "Split Rock." Another strange sight to the newcomer is Boulder Beach. This beach is composed entirely of boulder rocks from fist size to two feet in diameter. Winter storm waves have created a rare sight on the Pt. Reyes headlands.

The cove has been divided into three areas by the author. Area A is the study site, Figure 12. Area B is the location of frequent abalone hunters, and Area C is adjacent to a large sea lion rookery. The sea lions in this area are aggressive and will keep divers away from their rookery -- this is especially true in the June months, as I have been chased from the pups when participating in diving surveys. Area C, although not surveyed, is a favorite spot for local abalone hunters, and it still produces a good yield of 8-inch abalones for the aggressive hunter.

The study area at A will chiefly concern the subtidal work. The intertidal data will be omitted because of a mixup in computing the data. A resurvey of the intertidal region should be accomplished and the enclosed species list is from the author's work from a June 5, 1967 study which will serve as a base for additional reports.

Data and Interpretations of Subtidal Work

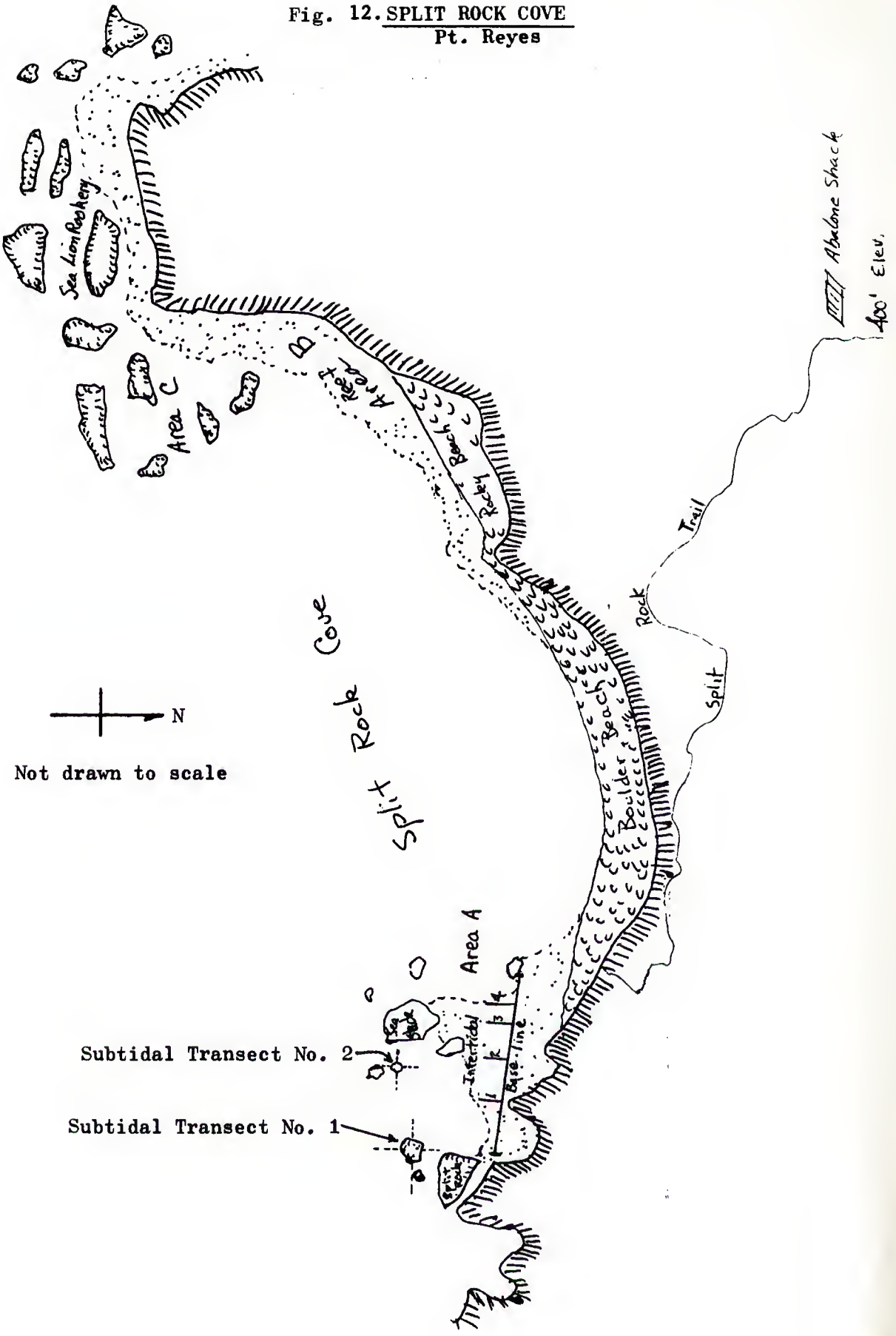
July 6, 1970
Tide, -0.5 at 8:18 a.m.
Water temperature, 49 degrees F
Weather, clear
Ocean condition, 3-5 foot swells

No. of abalones	$\bar{X}/m^2$	95% C.I.
Transect Site No. 1 = 6	0.3	$0.04 \leq M \leq 0.57$
Transect Site No. 2 = 87	4.4	$1.7 \leq M \leq 7.0$

Average abalone size, 8½ inches
Average growth layers, 16

In both rock locations, four 10-meter-long transects, and 20 sample counts per rock location illustrated that Transect site No. 2 yielded a high density of abalones. These abalones were found at the base of rocks; each, when pried off, showed a habitat scar on the rock where it resides. Figure 13 shows the placement of these abalones in relationship to water depth and algae. Apparently, they crawl to the kelp to feed and return to their habitat scar. Other scientists have theorized that they eat the rainment of algae that cascades down to their location. I am of the opinion that they move constantly, especially at night.

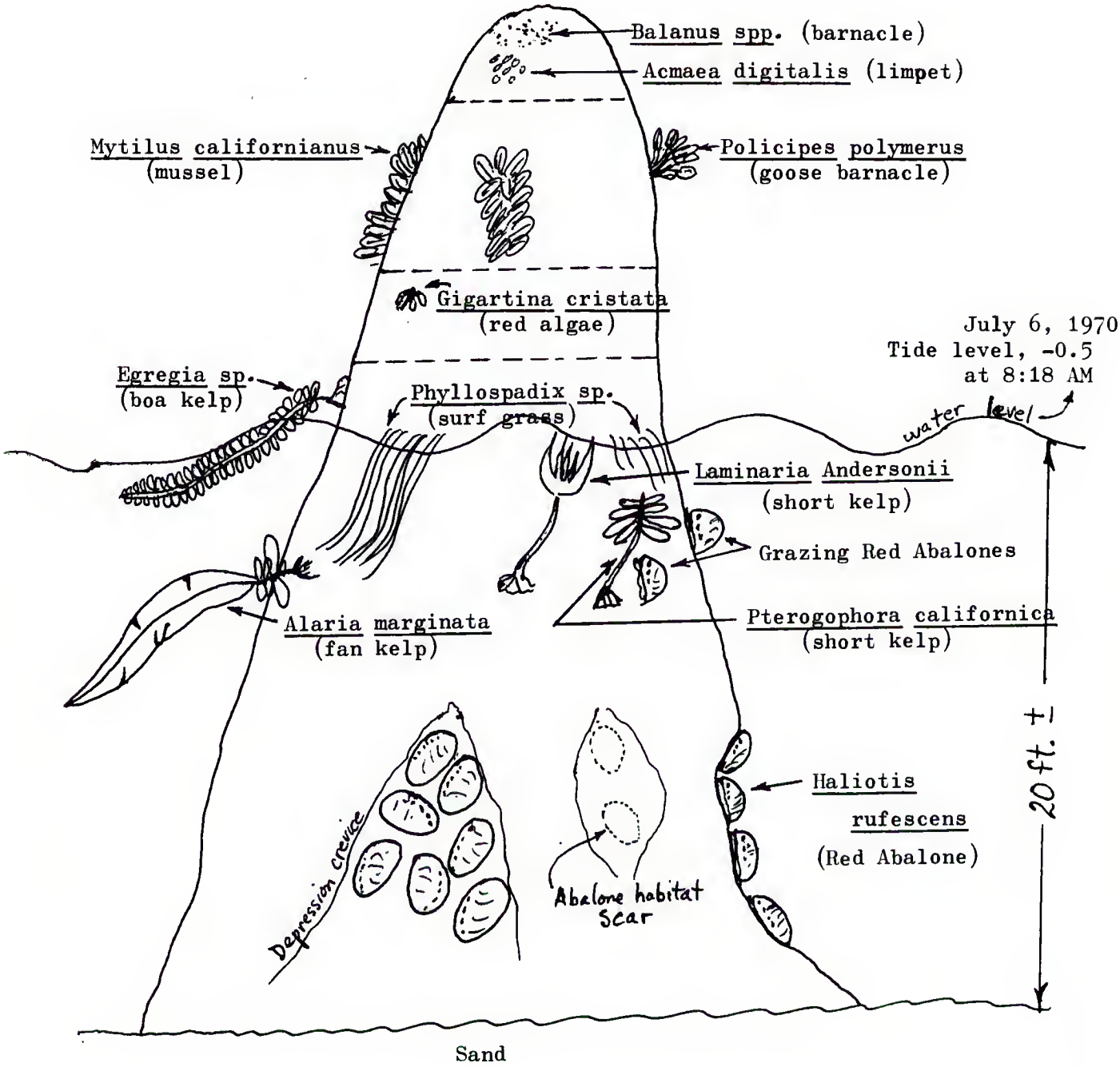
Fig. 12. SPLIT ROCK COVE
Pt. Reyes



From Figure 13, the zonation of abalones to algea reveal that in this location of Split Rock, in depths of about 20 feet, the red abalones are zonated at the base of these sea stacks. A few of the abalones were at the Pterogophora kelp zone, but since they did not have a habitat scar (a rock area made smooth by their foot attachment) we observed them grazing on the blades of Laminaria and Pterogophora. Their permanent spots would be at the base of the sea stacks. We have seen many abalones eating Pterogophora and thus we call this kelp an abalone indicator; that is, when we see this kelp, conditions should favor the presence of abalones.

Finally, from Appendix I, the abalones from this area are of large size, averaging 8½ inches in length and 16 growth layers, indicating fairly old abalones. Most of these abalones have on their shells the yellow sponge, Ciona celata, which bores into their shells.

Figure 13. ZONATION OF ABALONES TO ALGAE, Rock Transect Site No. 2, Split Rock, Pt. Reyes Park



F. BIG PIPE REEF, TOMALES PT. HEADLAND

Moving north, our next sampling took place at Big Pipe Reef, about 1300 yards south of Bird Rock on the Tomales Point headland. This reef area is also known to abalone hunters as Lower Ranch Reef. However, our students discovered a long oil pipe drill casing on the south end of this granite reef and thus named the reef after this pipe. This steel tube measures 16 inches in diameter and is about 400 feet long! Where the pipe came from is still a mystery. Since the pipe rests on a ridge-like fulcrum, it is possible for a tug to tow the pipe out into deep water. The pipe is now covered with a myriad of marine growth including many abalones, Figure 14A, B.

Both subtidal and intertidal crews found these granitic reefs to be very rich with a variety of marine life.

Subtidal Data and Interpretations, Big Pipe Reef

July 7, 1970 (Sub and Intertidal date)
Tide, -0.2 at 9:18 a.m.
Water temperature, 52 degrees F
Weather, clear skies
Ocean conditions, 3-5 foot swells
Underwater visibility, 8-15 feet

Abalone Data
Depth of water, 3 to 15 feet

	$\bar{X}/m^2$	95% C.I.
Abalones in crevices	6	$5.1 \leq \mu \leq 6.9$
Abalones on flat surfaces	2	$1.4 \leq \mu \leq 2.6$

Average size, 5-3/8 inches
Average growth layers, 7

N = 50, the number of overturned subtidal rocks; 15 Haliotis rufescens were observed less than 1 inch in length. Thus X = 0.3 of Haliotis rufescens under 1 inch per subtidal rock.

While some divers were developing the species list for this area, Figure 15, four divers concentrated on the square-meter estimates of the subtidal numbers of Haliotis rufescens, the red abalone, Figure 14B. The subtidal area had in certain locations the most dense population of abalones seen anywhere on the California coast. The crevice counts averaged 6 per square meter while the flat rock surfaces averaged 2 per square meter. In certain pockets the abalones were piled on top of each other and I counted 11 in one such crevice. Overall, the sizes of abalones in here are small; the average size, Appendix I, is 5-3/8 inches. The average number of growth layers is 7.

In general, I have hypothesized that there are so many abalones here that the growth is slow due to the competition for kelp blades. The Pterogophora kelp was sparse in this location.

Figure 14 A. TOMALES POINT - BIRD ROCK and BIG PIPE REEF AREA

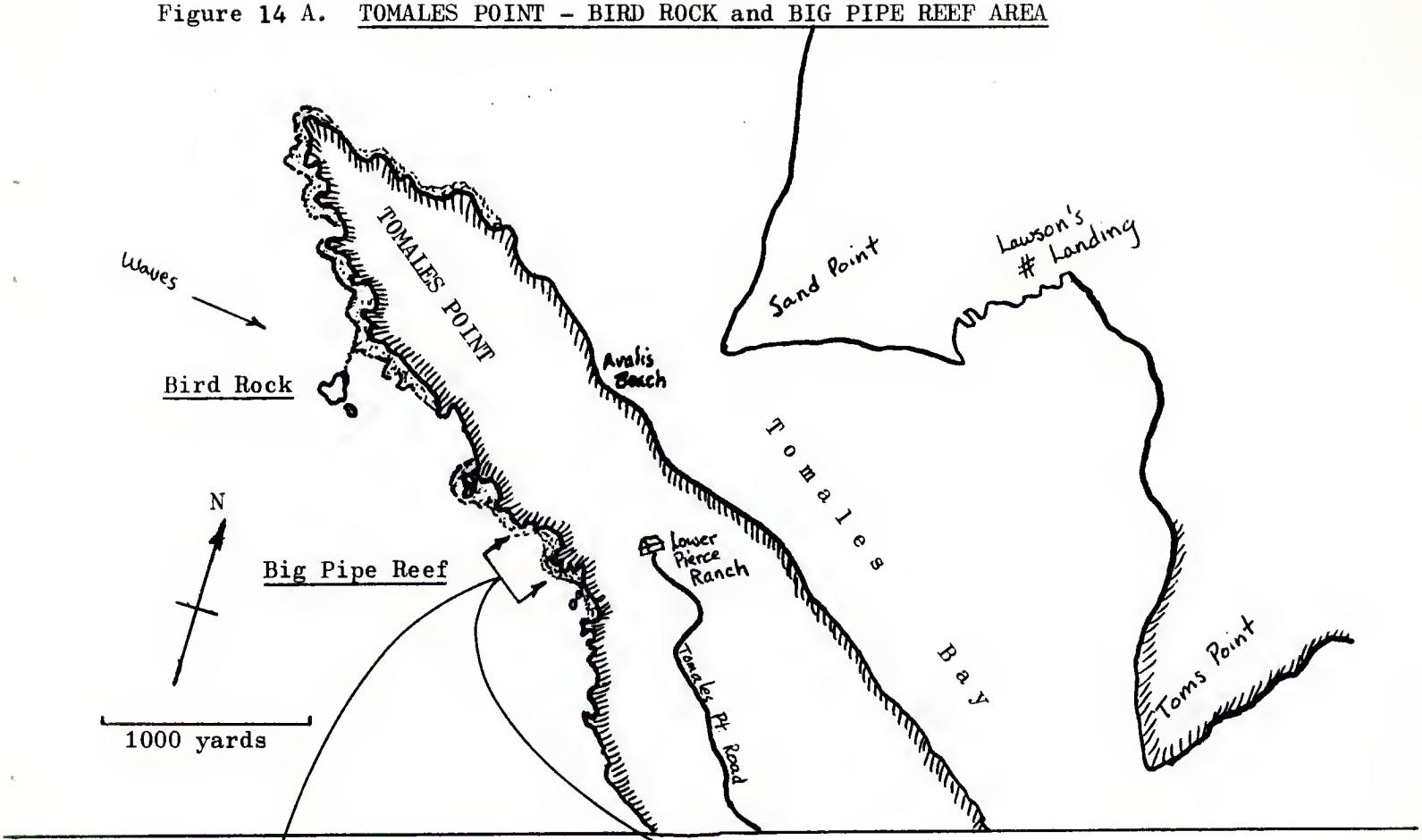
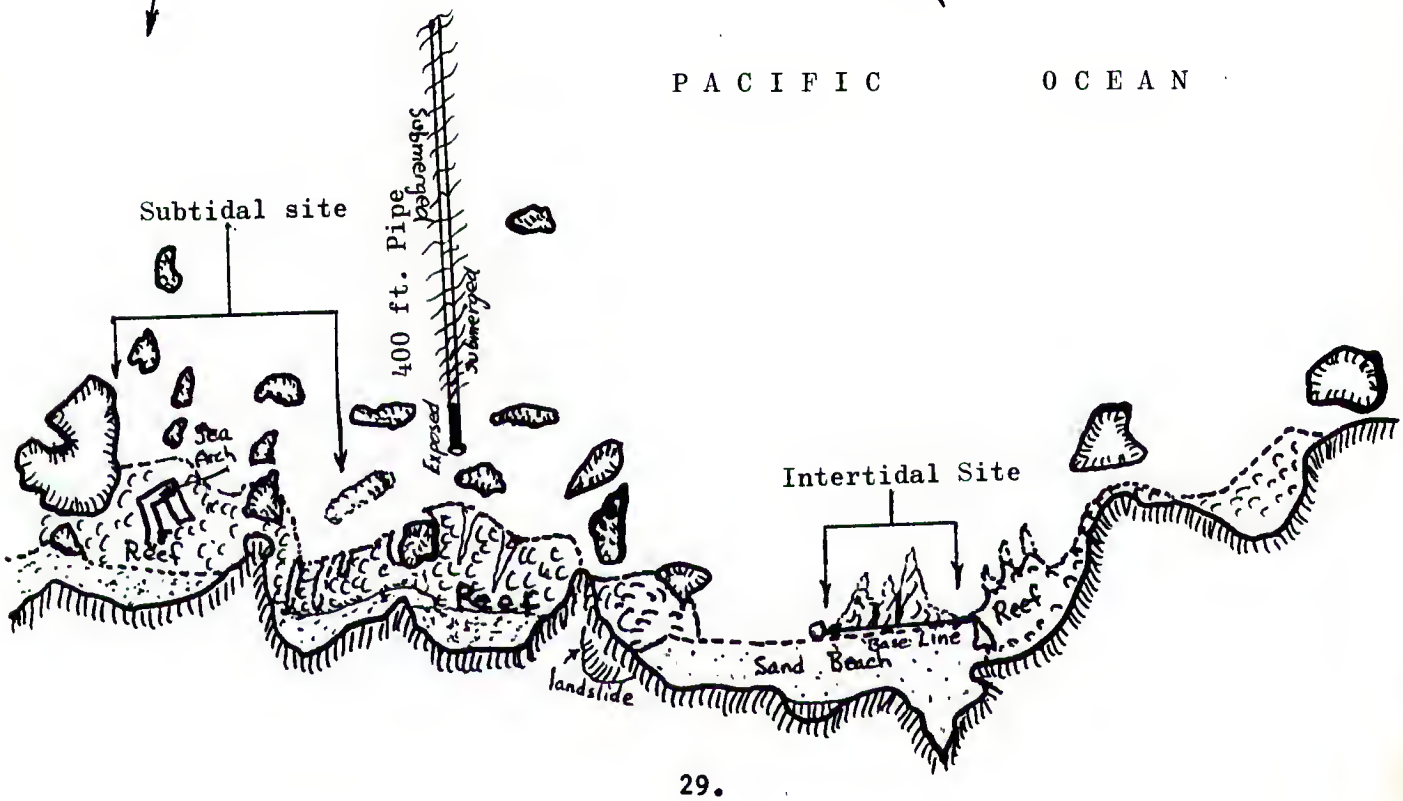


Figure 14 B. Big Pipe Reef

Not drawn to scale



Students Ed O'Connor and Dave Toponce, and I, after completing the square-meter count, started turning over rocks in waters 5 to 10 feet deep to look for the young abalones. Approximately 50 rocks were turned over and replaced in original position and 15 abalones less than 1 inch were found, giving an average of 0.3 per rock. The abalones ranged in size from ½ inch to 3/4 inch. Living under rocks, these young abalones are protected from their predators. According to my observations, I would say that this area has the greatest numbers of young abalones on the Pacific coast.

While no counts of sea urchins were made, we all concluded that of the numerous areas we have studied, this site contained fewer sea urchins than other areas where the abalone population was sparse. Apparently, the abalone and the sea urchins compete for the same food, and from my observations, in this one area out of the entire Pacific Coast, the abalones probably outnumber the sea urchins. However, if the sea urchin population continues to mushroom as it has in most areas throughout the Pacific Coast, this ecological change will, in time, no doubt occur here at Big Pipe Reef.

Intertidal Data and Interpretations, Big Pipe Reef

Number of laddered transects = 2
Number of square-meter counts = 40

14 red abalones, H. rufescens, were tagged with a yellow plastic marker to study migratory habits. All tagged specimens were less than 7 inches.

Figure 15. Major Intertidal Animals at Big Pipe Reef

Major Species	Sample mean X/m^2	Significant 95% Conf. Interval
Anthopleura elegantissima, sea anemone	91.6	$57.0 \leq M \leq 126.0$
Pollicipes polymerus, goose barnacle	81.7	$53.0 \leq M \leq 110.0$
Pachygrapsis crassipes, shore crab	6.0	$4.3 \leq M \leq 16.3$
Acmaea digitalis, limpet	1.3	
Littorina planaxis, littorine snail	3.2	$.1 \leq M \leq 6.4$
Acmaea scabra, limpet	2.6	$.2 \leq M \leq 5.4$
Tegula brunnea, brown turban snail	3.9	$1.7 \leq M \leq 6.1$
Tegula funebralis, black turban snail	37.3	$13.9 \leq M \leq 62.6$
Haliotis rufescens, red abalone	.11	--------

Like the other granitic intertidal reefs, this area has a large variety of species, Appendix X. The significant density counts appear in Figure 15, the solitary anemone, Anthopleura elegantissima, being the most numerous animal in the study samples. The black abalone, H. cracherodii, was seen in this area but none were found in the transects.

A total of 20 intertidal abalones were found, 14 of these were less than 7 inches, and they were tagged to denote migratory movements. These were placed back in their approximate spot, the date being July 7, 1970. About two weeks later, July 18, on a -1.7 tide, we returned to the area and not one of the 14 tagged Haliotis rufescens was observed at that location. Only one shell, tag number 5 was recovered; the shell was washed up on the beach and it appeared that someone had pried the foot off and thrown away the shell.

On August 25 and 28, 1970, a Larkspur man picked up three empty tagged shells on the Big Pipe Reef beach. The total of four recovered shells ranged in size from 6½ to 6-7/8 inches. We do not know specifically what caused the death of these abalones, but suspect that they were removed by abalone hunters and cleaned on the beach. The fate of the remaining tagged abalones is unknown at this time.

In all of our samples, only one abalone reached the legal sportsman size of 7 inches. Perhaps with only the availability of small abalones in this intertidal zone, hunters have the options of taking undersized abalones or not capturing their legal limit of five animals. Subtidal abalones were tagged at Bird Rock and one of the mollusks was observed 23 days later in exactly the same spot, see Bird Rock data.

G. BIRD ROCK, TOMALES PT.

Near the western tip of Tomales Point is Bird Rock Island, Figure 14A. This large granitic island made white with many years of bird guano will, in my opinion, be one of the park's most visited sites. Except for the southeast side of the island, there are reefs that surround the area between the Rock and the main peninsula. This area, Figure 16, would be an ideal location for a National Underwater Park, similar to those in Florida. The underwater visibility in this area has always been favorable as recalled in some 30 dives that I have made here throughout the years. Figure 16 illustrates some of the outstanding organisms that can be seen in this area.

Blow Hole Rock, Figure 16, is one of the great sights to see in this area. On the southeast side of this little island is a one-foot crack where waves enter with great force. The outlet of these waves is a small hole about three inches across, and nearly closed by the dense growth of mussels. The water geyser spray has been seen to go as high as 30 feet and the sound to nearby divers is like that of thunder and a hundred locomotive trains.

Subtidal Data and Interpretations, Bird Rock Area

June 24, 1970
Tide, -0.5 at 10:18 a.m.
Water temperature, 56 degrees F
Water visibility, 10 feet
Waves, 1 - 3 feet
Weather, clear

8 Transects, 40 m^2 Samples	$\bar{X}$/per 10-meter transect	95% C.I.
Red abalones	9.0	$7.5 \leq \mu \leq 10.4$
Red sea urchins	73.7	$66.9 \leq \mu \leq 80.6$

Average size of red abalone, 5½ " to 6-3/4"
Average number of growth layers, 12

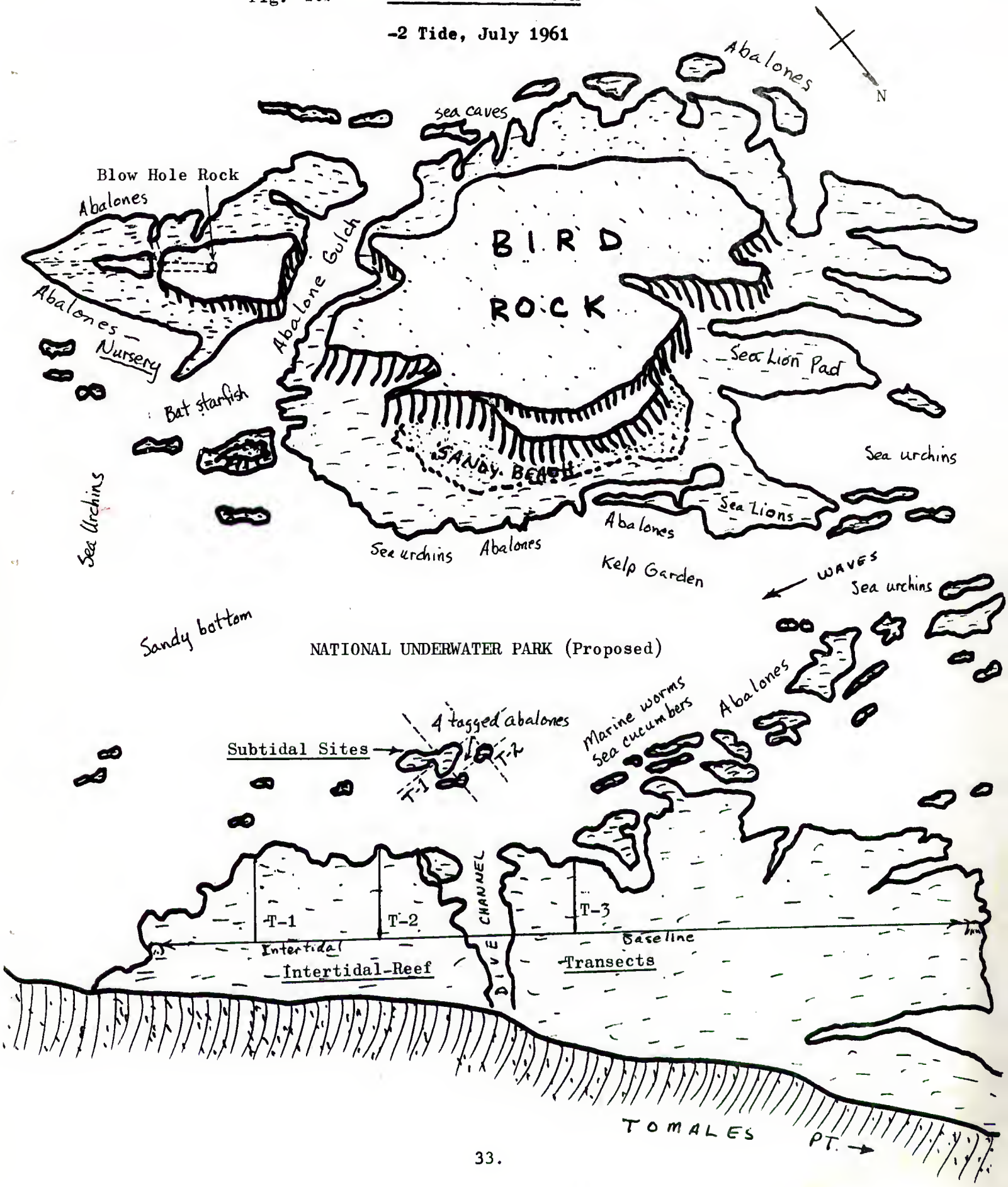
Again, with the subtidal emphasis on the studies of the red abalones and sea urchins, the diving team studied two wash rocks just off the main reef dive channel, Figure 16. Incidentally, this dive channel provides easy access into the proposed National Underwater Park. At the wash rocksites eight compass transects and 40 square-meter counts were recorded. For each transect of 5 sampling counts, we arrived at a mean estimate of 9.0 Haliotis rufescens. For the same transects, we estimated a mean of 73.7 red sea urchins, Strongylocentrotus franciscana. At these transects all the abalones were less than 7 inches. The sea urchins were of large size; the average appeared to be about 4 inches in diameter.

Four abalones were tagged, ranging from 5½ inches to 6-3/4 inches. These were carefully replaced in their exact spot in about four feet of water, June 24, 1970. Only July 17, 23 days later, we surveyed this same spot and found the 6-3/4 inch abalone still in its exact location.

Not drawn to scale

Fig. 16. **BIRD ROCK**

-2 Tide, July 1961



The other three could not be located due to a heavy surge and low visibility. Knowledge of the migration of abalones is still meager and our brief experiment did not support the migration theory -- that they do move for food.

Bird Rock is surrounded with abalones, most of them small and fairly young. One nursery of small ½ inch abalones were located on the east side of Blow Hole Rock, Figure 16. Sea urchins probably outnumber abalones 100 to 1 in this area. The bat starfish population next to Blow Hole Rock was large. Abalone Gulch, between Blow Hole Rock and Bird Rock, is about 12 feet in water depth and is lined with abalones. In the suggested underwater park, the large bed of short kelp, Laminaria and Pterogophora, together with the colorful marine worms and sea cucumbers add much justification for a protected marine reserve where divers will see these animals and plants.

Intertidal Data and Interpretations, Bird Rock Reef

On the same day as the divers, June 24, the intertidal crew laid out a base line with three transects, see Figure 16. A total of 32 square-meter samples were studied.

Major species	$\bar{X}/m^2$	Significant 95% C.I.
Anthopleura xanthogrammica, sea anemone	25.7	$20.1 \leq M \leq 31.0$
Mytilus californianus, mussel	26.6	$17.7 \leq M \leq 53.9$
Tegula funebralis, black turban snail	18.3	$4.9 \leq M \leq 31.7$
Pollicipes polymerus, goose barnacle	12.3	$7.5 \leq M \leq 16.9$
Balanus glandula, acorn barnacle	11.9	$9.9 \leq M \leq 14.0$
Petrolisthes cinctipes, porcelain crab	43.9	$23.3 \leq M \leq 64.5$
Strongylocentrotus purpuratus, sea urchin	3.4	$1.9 \leq M \leq 4.9$
Pisaster ochraceous, purple starfish	.9	$.13 \leq M \leq .24$

As in the other Pt. Reyes areas that were studied, the same organisms appeared to be the most numerous. The species list, Appendix XI, indicates the varieties of other forms that were observed but not in large numbers. In general, the granitic reefs of the Pt. Reyes National Seashore Park do indicate a rich fauna and flora.

No abalones were observed in these intertidal transects at Bird Rock. As we descended into the lower tide zones, a few red abalones -- all small sizes, around 3 to 5 inches. The small intertidal abalones are probably attributable to the boatloads of abalone hunters that have ferried across Tomales Bay from Lawson's Landing, Figure 14A. Such

pressures over the years have been relentless. Moreover, the population of abalones subtidally in the proposed underwater park will also diminish because of the constant pressure of abalone hunters who boat in from surrounding harbors of Morro Bay and Tomales Bay.

The Bird Rock area concludes the subtidal and intertidal work by our College of Marin students in the summer of 1970.

H. OTHER SIGNIFICANT OBSERVATIONS

In this section, I will review briefly some of the significant observations that I have recorded in past years while scouring the Point Reyes countryside.

1. Point Reyes Beach

This ten-mile-long beach is populated with two typical beach organisms:

a. Orchestoidea californiana, the beach flea that hops around the upper beaches by doing a one and one-half flip to gain more distance in its jump. There are many of these organisms under the washed up kelp.

b. Emerita analoga, the surf mole crab, is abundant throughout the low surf zone. Many young mole crabs were observed in the beach area northwest of the Pt. Reyes lighthouse.

Generally, the beach slope is to steep for good studies of beach organisms.

2. Abbotts Lagoon

In the summer of 1964, our college students seined this lagoon for fish life. We found some surf perch and sculpins which probably were trapped in the lagoon during times when the beach barrier between the lagoon and the ocean was opened by battering waves. The most significant fish in the area were large sticklebacks, Gasterosteus aculeatus. The seine caught these by the thousands, some as long as four inches, and all were carefully returned to the lagoon alive.

3. Tomales Point

The very tip of Tomales Point contains some facinating scenery and tidepools. However, the most outstanding feature of the tip in my opinion are the many shells embedded in the black top soil right at the tip. These shells probably indicate an Indian kitchen midden, for I have found small arrow heads in among the shells.

The second interesting scene are the sheets of orange algae that cling to the sheer surfaces of the granitic cliffs. Some have mistakenly referred to these orange mats as lichens. They are a green algae, belonging to the division Chlorophyta, family Trentepohiaceae. The chlorophyll in the laminated chloroplasts are masked by a red pigment, haematochrome. Actually, the largest mats of Trentepohlia aurea can be seen just north of the Chimney Rock cliffs on the Pt. Reyes headland. Generally, this algae is widespread throughout the coastal and bay rocks which border the water's edge.

4. Tomales Bay

A discussion on the marine life in Tomales Bay would occupy volumes. The University of the Pacific's Dillon Beach Marine Laboratory has published many papers on the biotic and abiotic factors in the Bay. I personally have participated in the ecological studies of Tomales Bay at the Dillon Beach laboratory and have concluded that Tomales Bay is truly one of the outstanding protected bays for fauna and flora anywhere in California. From the large clam populations to the transparent sea cucumber, Leptosynapta albicans, found at Hearts Desire Beach, Figure 2, and at other beaches, this Bay has both quantity and variety of organisms.

Like many areas adjacent to roads and highways, this area's ecology has been changed by people pressure. For instance, the rock cockle, Protothaca staminea, has been hard hit by clam diggers alongside the eastern shores of the Bay and in the Hearts Desire Beach area. The population of the horseneck clam, Tresus nuttallii, has diminished greatly near the Lawson's Landing mudflats. With increased encroachment of man into the Bay by feet and hands, boats, harbors, development earth fills, housing, man-made siltation runoffs, and waste pollution, the arrays of fauna and flora is threatened with eminent extinction.

IV. REVIEW and RECOMMENDATIONS

This review of the Point Reyes study areas will incorporate some recommendations that represent my experiences over the years in investigating these marine environments. The major recommendation is that this great Seashore Park be protected and maintained as a wilderness area. The fauna and flora represent natural-wild conditions, unlike that of other nearby metropolitan - suburban sea coast locations whose ecology has been greatly altered.

A. The Review of Study Sites, (See Figure 2)

1. Duxbury Reef

Duxbury Reef is geologically a part of the Point Reyes Peninsula. The reef is not a part of the National Seashore Park, but many officials, indluding United States Senator Alan Cranston, have voiced regrets that it was not part of the original Seashore proposal. Duxbury Reef is a shale intertidal reef, the largest in North America; it can house over 61 football fields! With leadership exercised by the Marin County Board of Supervisors, and through the cooperative efforts of Mr. Pierre Joske, Director of the Department of Parks and Recreation, with the College of Marin scientists, the reef will become a Marine Reserve where the wildlife will be protected. I strongly feel that the new Duxbury Reef Reserve (March 1, 1971) will enhance and supplement the policies of the Pt. Reyes National Seashore Park.

2. Double Point

The outstanding marine fauna are the giant beds of the California mussel, Mytilus californianus. Some of these giant mussels reach a length over 8 inches. There is also a significant population of large size abalones over 9 inches in length which should be protected from eager hunters. Finally, besides the breathtaking scenery, the year-around herd of sea lions and seals should not be allowed to be driven into the sea by people walking on the Double Point Cove Beach.

3. Sculpture Beach

The large kelp, Macrocystis spp., grows very well in this area. These beds are the home of many fish and mollusks. Perhaps, there could be the introduction of a small herd of sea otters here as an experiment. There are certainly enough sea urchins in the area to provide food for these otters for many years. The abalone population, although small at Sculpture Beach, is probably of significant density near the Bear Valley Trail area. Constant monitoring of the effects of sea otters feeding on urchins and abalones here would provide important data for the whole state. Sea urchins are growing wild throughout the Pacific Coast, and one of the few natural predators of these urchins is the sea otter! Underwater photography in this area would also be very popular.

4. Drakes Estero Area

Like Tomales Bay and Bolinas Lagoon, the Drakes Estero area needs protection as a natural wildlife lagoon. Man is eating the horseneck clam, Tresus nuttallii, and the moon snail, Polinices lewisi, faster than the natural replacement of these organisms. The giant geoduck clam, Panope generosa, occupies an important spot within the Estero. In my field trips up and down the Pacific Coast, I have found that only Drakes Estero has these large clams in significant numbers.

The commercial oyster farm, Johnson's Oyster Company, should be an asset to the Lagoon environment. Sea farming or mariculture is one of man's contributions to replenish the animals he removes for food. I hope that the Johnson's Oyster Company can provide a museum and perhaps expand the mariculture of other mollusks, i.e., clams and cockles for the benefit of replenishing the sea. Careful monitoring of the ecological effects of mariculture should determine the value of such activities in Drakes Estero. In our plankton hauls, the diatom, Cosinodiscus spp., was teeming in numbers. This diatom is a favorite food for oysters, clams, and young abalones. Perhaps the rainment of cattle fertilizers in the Estero valleys has contributed to the rich diatom growth and thus enhanced the production of oysters and other giant mollusks. There is a balance of life in the Estero and man must be careful not to disrupt the ecology.

5. Chimney Rock and Split Rock Areas

These granitic reefs contain a diversified fauna and flora. The abalone population all along the southern exposure of the Pt. Reyes headlands should be maintained, even protected. These waters contain a large nursery of abalones, young ones of all sizes. Offshore in the wave-tossed wash rocks, are older abalones which are remnants that survived the commercial divers who worked these areas during World War II days. Many times I have seen individuals poaching abalone in this area. Mr. J. H. Mendoza who has resided at this Pt. Reyes ranch area for years has also expressed alarm at the sight of divers with SCUBA gear taking abalones from small boats anchored off this coast. The "keep off my land" policies of Mr. Mendoza have, in my opinion, protected these older abalones from the onslaught of hunters.

6. Big Pipe Reef and Bird Rock Area

In my diving excursions from Baja California to Vancouver, British Columbia, I have searched for young abalone nurseries. Nowhere have I seen such densities of young abalones from ½ inch to 7 inches than here at Big Pipe Reef and Bird Rock area. Such populations should be thinned to a certain degree and perhaps replanted elsewhere to provide food for the California sport hunter. Generally, the abalones in these areas are not large -- the majority being in the 5 to 7 inch range. Such a nursery of abalones must be maintained and nurtured.

The protected waters between Bird Rock and the Tomales Point peninsula are outstanding enough to warrant the creation of a National Underwater Park as part of the Pt. Reyes Seashore system--just like the ones on the southern tip of Florida. The entire sea area from McClure's Beach to Tomales Point is a choice environment for the mollusks, such as the abalones. While the entire California Coast undergoes pressure from the abalone hunters, Pt. Reyes could well be the haven or heaven for these animals in the twilight years of this century.

7. Final Remarks

In the Biblical book of Genesis, the Lord God commanded man to "be fruitful, multiply, and replenish the earth and subdue it." (Genesis 1:28). Man has certainly been fruitful with his numbers. Man has not replenished and subdued nor controlled the earth. I am told that the original Hebrew and the Random House Dictionary generally agree in interpretation about the word:

replenish

1. to make full or complete again, as by supplying what is lacking, used up, etc.; to replenish one's stock of food.

Random House Dictionary, 1967, p. 1217

I sense that the Lord God knew that man would be using up the earth's natural resources but His command to us has not been followed -- selfishness is not at all a big mystery. In regards to the ocean, man is a hunter. Yes, he has replenished the freshwater trout and salmon, but in respect to marine life resources, he has taken and not replenished.

I am not anti-sportsman -- I just want the remnant of today's marine life to survive so that they may be observed by the generations of humans in the next decades. If I can stimulate man to spend some dollars to create a mariculture in abalones, other mollusks, fish, etc., then we will be upholding, in part, the Lord God's command to replenish. The animal and plants of 1971 do not belong to today's California sportsman with his $3.00 hunting license--these organisms belong to the present and future generations of all Californians! I hope that the individual who buys a marine fishing license in the year 2000 (for about $20.00?!) will have the opportunity to dive and come up with at least one abalone; that is, if industrial waste has not polluted all marine life.

At this moment, Mr. Earl Ebert, fishing biologist for the California Department of Fish and Game, is applying the finishing touches to a laboratory South of Carmel that will initiate the studies of marine mariculture. This project is 50 years overdue in this state. Some of the millions contributed by sportsmen for marine fisheries ought to be redirected to such mariculture work all over the state. Unfortunately, most of the money is spent on administering a "policing" work up and down the coast.

The Point Reyes National Seashore Park has been referred to as an "island in time." There is no question that this valuable "island" should be preserved and protected. With the consideration of conservation policies for this park, I hope that a portion of the rich natural resources of this land can be a contributor to the replenishment of other coastal areas that have been under the attacks of man.

The End.

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APPENDIX I - REVIEW OF HALIOTIS RUFESCENS

GROWTH LAYER AND SIZE DATA

AREA	DATE RANGE month/year	Total abalones examined	Number of GROWTH LAYERS Avg.	(range)	SHELL SIZE nearest 1/8" Average	(range)
Santa Cruz Island	1/70	1	10	(10)	8-5/8"	(8-5/8)
Santa Rosa Island	1/70-10/70	5	16	(13-18)	9-3/8"	(8-6/8 to 10-3/8)
San Miguel Island	1/70	1	-		9-1/8"	(9-1/8)
Morro Bay	8/69	1	27	(27)	10-4/8"	(10-4/8)
Davenport	/65- 6/70	29	23	(8-32)	9-2/8"	(8-4/8 to 10-6/8)
Duxbury Reef	7/68	8	25	(20-30)	9-2/8"	(8-4/8 to 10-6/8)
Double Point	6/70	6	26	(25-27)	9-4/8"	(7-0 to 9-6/8)
Sculpture Beach	7/70	2	13	(11-14)	8-4/8"	(8-4/8)
Pt. Reyes Coast Guard Station	11/68	5	18	(16-20)	8-3/8"	(8-0 to 8-6/8)
Chimney Rock	7/70	8	8	(0-12)	5-7/8"	(0-5/8 to 7-4/8)
Split Rock	6/68- 9/70	47	16	(8-25)	8-4/8"	(7-0 to 9-4/8)
Big Pipe Reef	7/70-12/70	46	7	(0-20)	5-3/8"	(0-2/8 to 8-0)
Bird Rock	5/69- 7/70	67	12	(0-32)	7-2/8"	(1-4/8 to 10-5/8)
Rock Point	6/70	1	27	(27)	9-0"	(9-0)
Fort Ross	5/70	8	9	(1-17)	7-1/8"	(4-4/8 to 8-4/8)
Ocean Cove	5/70	18	10	(7-15)	8-0"	(7-2/8 to 8-4/8)
Salt Point	10/69- 5/70	43	9	(3-22)	7-6/8"	(7-0 to 9-2/8)
Kruse Ranch	1/70	5	15	(12-21)	8-3/8"	(8-1/8 to 8-6/8)
Sea Ranch	8/69-11/70	3	16	(9-30)	8-6/8"	(8-0 to 10-1/8)
Anchor Bay	11/69	4	12	(9-14)	8-0"	(7-3/8 to 8-6/8)
Pt. Arena	8/69-11/69	88	16	(8-26)	7-7/8"	(6-6/8 to 9-0)
Navaro River	7/70	3	22	(20-23)	9-1/8"	(8-6/8 to 9-4/8)
Van Damme	5/70- 7/70	17	8	(0-15)	6-5/8"	(2-6/8 to 8-0)
Russian Gulch	5/70- 7/70	20	9	(0-16)	6-7/8	(4-4/8 to 8-1/8)
		436	13.6	(0-32)	7-5/8"	(0-2/8 to 10-6/8)

Growth layers

26 abalones had indistinguishable growth layers.
28 abalones measured 5" or less; 90% of these had one or no observable growth layer.
As the abalone grows in length greater than 5", the number of growth layers increases rapidly, reaching as high as 32 growth layers for a 10-6/8" abalone.

APPENDIX II TAGGING H. RUFESCENS FOR MIGRATORY STUDIES

Area	Tag Number	Length	Sex
Big Pipe Reef Intertidal Study Sites	1-19351	6¼	M
	2-19352	6-7/8	F
	3-19353	6-7/8	F
	4-19354	6-5/8	F
	5-19355	6½	F
	6-19356	6-3/8	F
	7-19357	6-5/8	M
	8-19358	6-3/4	F
	9-19359	6	F
	10-19360	6-3/4	F
	11-19260	6-3/8	M
	12-19261	6-3/4	F
	13-19294	6½	M
	14-19298	6-7/8	M
Bird Rock Subtidal Site	15-19300	6-3/4	--
	16-19299	6	--
	17-19292	6 ¼	--
	18-19293	5 ½	--
Intertidal Site	19-19291	5	--
	20-19295	5 ¼	--
	21-19296	5 ½	--

Appendix IIIA

Species List for Double Point (Sub-tidal)

Algae

Chlorophyta - Green Algae

Spongomorpha

Phacophyta - Brown Algae

Fucus furcatus C. A. Agardh
Alaria marginata Postels and Ruprecht
Costaria costata (Turner) Saunders
Pterygophora californica (Postels)
Nereocystis luetkeana (Mertens) Postels and Ruprecht)
Postelsia palmaeformis Ruprecht
Egregia laevigata (Turner)
Laminaria andersoni Eaton
Laminaria farlowii Setchell
Laminaria sinclairii (Harvey) Farlow
Desmarestia munda Setchell and Gardner
Cystoseria osmundacea (Menzies) C. A. Agardh
Lessoniopsis littoralis (Lesson)
Collodesme californica (Postels)

Rhodophyta - Red Algae

Iridaea splendens
Endocladia muricata (Postels and Ruprecht) J. G. Agardh
Halosaccion glandiforne (Gnelin) Ruprecht
Gigartina corynbifera (Kutzing) J. G. Agardh

Porifera

Rhabdodernella nuttingi Urban. 1902
Leucosolenia eleanor Urban. 1905
Cliona celata Grant

Coelenterata

Anthopleura elegantissinia (Brandt, 1835)
Anthopleura xanthogrammica (Brandt, 1835)
Corynactis californica Carlgren, 1936
Aurellia aurita (Linnaeua, 1746)
Abietinaria greenii (Murray, 1860)
Aglaophenia latirostris Nutting, 1900
Aglasphenia struthionides (Murray, 1860)
Epiactus prolifera (Nerrill, 1869)

Annelida

Eudistylia polynorpna (Johnson, 1901)
Serpuia vernicuiaris Linnaeus, 1767

Arthropoda

Balanus nubilis Darwin, 1854
Balanus glandula Darwin, 1854
Scyra acutifrons Dana, 1852
Cancer productus Randall, 1839
Cancer antennarius Stimpson, 1856
Pugettia producta (Randall, 1839)
Pagurus henphillii (Benedict, 1892)
Pagurus samuelis (Stimpson, 1857)
Idothea resecata (Stimpson, 1857)

Mouusca

Pododesmus nacroschisna (Deshayes, 1839)
Teguia brunnea (Philippi, 1848)
Haliotis rufescens Swainson, 1822
Diaulula sandiegensis (Cooper, 1862)
Anisodoris nobilis (MacFarland, 1905)
Calliostona sp
Hernissenda crassicornis (Eschscholtz, 1831)
Cryptochiton stelleri (Middendorff, 1846)
Hinnites multirugosus (Gale, 1928)
Acmaca paleacea Gould, 1851
Tonicella lineata (Wood, 1815)

Bryozoan

Bugula californica Robertson, 1905

Echinodermata

Pisaster brevispinus (Stimpson, 1857)
Pisaster ochraceus (Brandt, 1835)
Pisaster giganteus (Stimpson, 1857)
Pycnopodia helianthoides (Brandt, 1835)
Patiria miniata (Brandt, 1835)
Dermasterias imbricata (Grube, 1857)
Leptasterias aequalis (Stimpson, 1862)
Henricia leviuscula (Stimpson, 1857)
Stronglyocentrotus franciscanus (Agassiz)
Cucunaria miniata Brandt, 1835
Stichopus californicus (Stimpson, 1857)
Ophiothrix spiculata LeConte, 1851
Solaster dawsoni Verill, 1878
Strongylocentrotus pupuratus (Stimpson)
Chordata

Styela montereyensis (Dall, 1872)
Clavelina huntsmani Van Name, 1931
Amaroucium californicum Ritter and Forsyth, 1917

Appendix IIIB.

Species list for Double Point (Intertidal)

Algae

Chlorophyta - green algae

Ulva lactuca Linnaeus
Spongomorpha coalita (Ruprecht) Collins
Enteromorpha intestinals (Linnaeus) Link

Phaeophyta - brown algae

Pterygophora californica Ruprecht
Nereocystis luetkeana (Mertens) Postels and Ruprecht
Alaria marginata Postels and Ruprecht
Egregia menziesii (Turner) Areschoug
Desmarestia munda Setchell and Gardner
Laminaria andersonii Eaton
Cystoseira osmundacea (Menzies) C.A. Agardh

Rhodophyta

Odonthalia floccosa (Esper) Falkenberg
Rhodomela larix (Turner) C. Agardh
Iridaea splendens Setchell and Gardner
Gigartina cristata (Setchell) Setchell and Gardner
Gigartina californica J. G. Agardh
Prionitis lanceolata Harvey
Cryptoplevra violacea (J. Agardh) Kylin
Porphyra perforata J. G. Agardh

Invertebrates

Coelenterata

Anthopleura elegantissima (Brandt, 1835)
Anthopleura xanthogrammica (Brandt, 1835)
Epiactis prolifera Verrill, 1869
Aglaophenia struthionides (Murray, 1860)

Arthropoda

Balanus glandula Darwin, 1854
Pachygrapsus crassipes Randall, 1839
Pagurus samuelis (Stimpson, 1857)
Pagurus hemphilli (Benedict, 1892)
Pagurus hirsutiusculus (Dana, 1851)
Hemigrapsus nudus (Dana, 1851)

Petrolisthes cinctipes (Randall, 1839)
Cancer productus Randall, 1839
Cancer antennarius Stimpson, 1856
Pugettia producta (Randall, 1839)
Pollicipes polymerus (Sowerby, 1833)
Ligia occidentalis Dana, 1853
Balanus cariosus (Pallas, 1788)
Hapalogaster cavicauda Stimpson, 1859 (1862)
Spirontocaris picta (Stimpson, 1871)
Tigriopus californicus (Baker, 1912)

Mollusca

Littorina planaxis Philippi, 1847
Littorina scutulata Gould, 1849
Acmaea scabra (Gould, 1846)
Acmaea paleacea Gould, 1851
Acmaea digitalis Eschscholtz, 1833
Tegula brunnea (Philippi, 1848)
Tegula funebralis (Adams, 1854)
Crepidula adunca Sowerby, 1825
Thais emarginata (Deshayes, 1839)
Mytilus californianus Conrad, 1837
Tonicella lineata (Wood, 1815)
Katharina tunicata (Wood, 1815)
Mopalia muscosa (Gould, 1846)

Bryozoan

Bugula californica Robertson, 1905

Echinodermata

Pisaster ochraceous (Brandt, 1835)
Leptasterias pusilla (Fisher, 1911)
Solaster dawsoni Verill, 1878
Pycnopodia helianthoides (Brandt, 1835)
Dermasterias imbricata (Grube, 1857)

Appendix IV A

Species List for Bear Valley - Sculpture Beach, Subtidal

Algae

Chlorophyta - green algae

Spongomorpha coalita (Ruprecht) Collins

Phaeophyta - brown algae

Pterygorpha californica Ruprecht
Nereocystis leutkeana (Mertens) Postels and Ruprecht
Laminaria Andersonii (Eaton)
Cystoseria osmundacea (Menzies) C.A. Agardth
Alaria marginata Postels and Ruprecht
Egregia menziesii (Turner) Areschoug
Desmarestia munda(Setchell and Gardner)
Coilodesme californica Ruprecht
Costaria costata (Turner) Saunders
Lessoniopsis littoralis (Farlow and Setchell) Reinke
Postelsia palmaeformis Ruprecht

Rhodophyta - red algae

Iridaea splendens Setchell and Gardner
Porphyra perforata J. G. Agardh
Halosaccion glandiforme (Gmelin) Ruprecht

Intertebrates

Porifera

Rhabdodermella nuttingi Urban, 1902
Leucosolenia eleanor Urban, 1905
Cliona celata Grant, 1932

Coelenterata

Abietenaria greenei (Murray, 1860)
Anthopleura xanthogrammica (Brandt, 1835)
Epiactus prolifera Verrill, 1869
Corynactis californica Carlgren, 1936
Aurellia aurita (Linnaeus, 1746)

Ctenophora

Metridium senile
Pleurobrachia bachei A. Agassiz, 1860

Annelida

Serpula vermicularis Linnaeus, 1767
Eudistylia polymorpha (Johnson, 1901)

Arthropoda

Pagurus samuelis (Stimpson, 1857)
Pagurus hemphilli (Benedict, 1892)
Balanus nubilus Darwin, 1854
Balanus glandula Darwin, 1854
Cancer productus Randall, 1839
Cancer antennarius Stimpson, 1856
Idothea resecata (Stimpson, 1857
Pugettia producta (Randall, 1839

Mollusca

Pododesmus macroschisma (Deshayes, 1839)
Tegula brunnea (Philippi, 1848)
Tonicella lineata (Wood, 1815)
Cryptochiton stelleri (Middendorff, 1846)
Haliotis rufescens Swainson, 1822
Haliotis wallalensis Stearns, 1899
Octopus sp.
Hermissenda crassicornis (Eschscholtz, 1831
Diaulula sandigensis (Cooper, 1862)
Anisodoris nobilis (Mac Farland, 1905)
Calliostoma ligatum (Gould)
Acmaea paleacea Gould, 1851
Hinnites multirugosus (Gale, 1928)

Bryozoan

Bugula californica Robertson, 1905

Echinodermata

Pisaster ochraceous (Brandt, 1835)
Pycnopodia helianthoides (Brandt, 1835)
Pisaster ochraceous (Brandt, 1835)
Pycnopodia helianthoides (Brandt, 1835)

Pisaster brevispinus (Stimpson, 1857)
Patiria miniata (Brandt, 1835)
Dermasteria imbricata (Grube, 1857)
Leptasterias aequalis (Stimpson, 1862)
Henricia leviuscula (Stimpson, 1857)
Pisaster giganteus (Stimpson, 1857)
Strongylocentrotus franciscanus (Agassiz)
Strongylocentrotus purpuratus Stimpson
Cucumaria miniata Brandt, 1835
Stichopus californicus (Stimpson, 1857)
Ophiothrix spiculala Le Conte, 1851
Solaster dawsoni Verrill, 1878

Chordata

Styela montereyensis Dall, 1872
Amaroucium californicum Ritler and Forsyth, 1917
Clavelina huntsmani Van Name, 1931
Zalophus californianus sea lion

Appendix IV B

Species list for Bear Valley - Sculptured Beach (Intertidal)

Algae

Chlorophyta - green algae

Ulva lactuca Linnaeus
Enteromorpha intestinalis (Linnaeus) Link

Phaeophyta - brown algae

Ralfsia pacifica Hollenberg
Pelvetia fastigata (J. G. Agardh) De Toni
Fucus furcatus C. A. Agardh
Alaria marginata Postels and Ruprecht
Egregia menziesii (Turner) Areschoug

Rhodophyta - red algae

Endocladia muricata (Postels and Ruprecht) J. G. Agardh
Corallina chilensis Decaisne
Iridaea splendens Setchell and Gardner
Gigartina cristata Setchell (Setchell and Gardner)
Gigartina canaliculata Harvey
Porphyra perforata J. G. Agardh

Invertebrates

Coelenterata

Anthopleura xanthogrammica (Brandt, 1835)
Anthopleura elegantissima (Brandt, 1835)

Arthropoda

Petrolisthes cinctipes (Randall, 1839)
Hemigrapsus nudus (Dana, 1851)
Balanus glandula Darwin, 1854
Pollicipes polymerus Sowerby, 1833
Pachygrapsus crassipes Randall, 1839
Balanus cariosus (Pallas, 1788)

Mollusca

Mytilus californianus Conrad, 1837
Thais emarginata (Deshayes, 1839)
Acmaea persona Eschscholtz, 1833

Mollusca

Acmaea scabra (Gould, 1846)
Acmaea digitalis Eschscholtz, 1833
Tegula funebralis (Adams, 1854)
Tegula brunnea (Philippi, 1848)
Mopalia lignosa (Gould, 1846)
Littorina planaxis Philippi, 1847
Littorina scutulata Gould, 1849
Acmaea pelta Eschscholtz, 1833

Echinodermata

Pisaster ochraceous (Brandt, 1835)
Strongylocentrotus pupuratus (Stimpson)

Appendix V A

Species list for Drakes Estero (Subtidal)

Algae

Chlorophyta - green algae

Ulva lactuca Linnaeus
Ulva expansa
Enteromorpha compressa (Linnaeus) Greville

Phaeophyta - brown algae

Macrocystis integrifolia Bory
Fucus furcatus C.A. Agardh
Pelvetiopsis limitata (Setchell) Gardner
Pelvetia fastigata (J. G. Agardh) De Toni
Nereocystis luetkeana (Mertens) Postels and Ruprecht

Rhodophyta - red algae

Gracilaria verrucosa (Greville) Papenfuss
Endocladia muricata (Postels and Ruprecht) J. G. Agardh
Porphyra perforata J. G. Agardh

Invertebrates

Coelenterata

Aurellia aurita (Linnaeus, 1746)
Anthopleura elegantissima (Brandt, 1835)
Chrysaora melanaster Brandt, 1838
Epiactis prolifera Verrill, 1869

Annelida

Axiothella rubrocincta (Johnson, 1901)
Neries procera Ehlers, 1868
Pista pacifica Berkeley, 1942
Thelepus crispus Johnson, 1901
Eudystalia polymorpha (Johnson, 1901)

Arthropoda

Crago franciscorum (Stimpson, 1859)
Crago nigricauda (Stimpson, 1856)
Metacaprella kennerlyi (Stimpson, 1864)
Cancer magister Dana, 1852
Pugettia gracilis Dana, 1851

Appendix V B

Species list for Drakes Estero (Intertidal)

Flora

Zostera marina

Invertebrates

Coelenterata

Polyorchis pacifica (Torrey, 1909)

Annelida

Nephtys caecoides Hartman, 1938
Neanthes brandti (Malmgren, 1866)
Axiothella rubrocincta (Johnson, 1901)
Pista pacifica Berkeley, 1942
Eudystylia polymorpha Johnson, 1901

Sipunculoid

Sipunculus nudus Linnaeus, 1766

Echuiroidea

Urechis caupo Fisher and MacGinitie, 1928

Phoronidea

Phoronopsis hameri

Mollusca

Nassarius fossatus (Gould, 1849)
Nassarius cooperi (Forbes, 1850)
Polinices lewisii (Gould, 1847)
Phyllaphysia zosteracola
Tresus nuttalli (Conrad, 1837)
Olivella biplicata (Sowerby, 1825)
Saxidomus nuttalli Conrad, 1837
Hermissenda crassicornis (Eschscholtz, 1831)
Panope generosa Gould, 1850
Macoma secta (Conrad, 1837)

Arthropoda

Cancer antennarius Stimpson, 1856
Fabia subquadrata Dana, 1851
Metacaprella kennerlyi (Stimpson, 1864)
Pinnixa longipes (Lockington, 1877)
Scleroplax granulata Rathbun, 1893

Anthropoda

Scleroplax granulata Rathbun, 1893
Cancer productus Randall, 1839
Cancer antennarius Stimpson, 1856
Pugettia producta (Randall, 1839)
Pachygrapsus crassipes Randall, 1839
Hemigrapsus nudus (Dana, 1851)
Petrolisthes cinctipes (Randall, 1839)
Balanus glandula Darwin, 1854
Idothea resecata (Stimpson, 1857)
Callianassa californiensis Dana, 1854
Upogebia pugettensis (Dana, 1852)
Spirontocaris paludicola (Holmes, 1900)
Ligia occidentalis Dana, 1853
Caprella equilibra Say, 1818
Hemigrapsus oregonensis (Dana, 1851)

Mollusca

Polinices lewisii (Gould, 1847)
Nassarius cooperi (Forbes, 1850)
Nassarius fossatus (Gould, 1849)
Olivella biplicata (Sowerby, 1825)
Littorina planaxis Philippi, 1847
Littorina scutulata Gould, 1849
Hermissenda crassicornis (Eschscholtz, 1831)
Triopha carpenteri (Stearns, 1873)
Panope generosa Gould, 1850
Tresus nuttalli (Conrad, 1837)
Saxidomus nuttalli Conrad, 1837
Sanguinolaria nuttalli Conrad, 1837
Macoma secta (Conrad, 1837)
Macoma nasuta (Conrad, 1837)
Clinocardium nuttalli Conrad, 1837
Mopalia ciliata (Sowerby, 1840)
Tonicella lineata (Wood, 1815)
Pododesmus macroshisma (Deshayes, 1839)
Octopus sp.

Echiuroidea

Urechis caupo Fisher and MacGinitie, 1928

Sipunculoidea

Phascolosoma agassizii Keferstein, 1866
Sipunculus nudus Linnaeus, 1766

Phoronidea

Phoronopsis viridis Hilton, 1930

Chordata

Cymatogaster aggregata Gibbons
Ophiodon elongatus (Girard)
Citharichthys stigmaeus Jordan and Gilbert
Citharichthys sordidus (Girard)
Leptocottus armatus Girard
Hexagrammos decagrammus (Pallas)
Hyperprosopon argenteum (Gibbons)
Sebastolobus alsscanus Bean
Epigeichthys atro-purpureus (Kittlitz)

Appendix VI A

Species List for Drakes Beach (Sub-tidal)

Algae

Phaeophyta - Brown Algae

Marcrocystis pyrifera (Linnaeus) C. A. Agardh
Nereocystis luetkeana (Mertens) Postels and Ruprecht

Coelenterata

Anthopleura elegantissima (Brandt, 1835)
Chrysaora melanaster Brandt, 1833

Annelida

Serpula vermicularis Linnaeus, 1767
Arabella semimaculata (Moore, 1911)
Emerita analoga
Euzonus mucronata (Treadwell, 1914)
Nephtys californiensis Hartman, 1938

Arthropoda

Archaeomysis maculata (Holmes)
Balanus glandula Darwin, 1854
Cirolana harfordi (Lockington, 1877)
Orchestoidea californiana (Brandt, 1851)
Pachygrapsus crassipes Randall, 1839
Pollicipes polymerus (Sowerby, 1833)
Orchestoidea corniculata Stout, 1913
Cancer antennarius Stimpson, 1856
Callianassa californiensis Dana, 1854

Mollusca

Siliqua patula (Dixon, 1788)
Mytilus californianus Conrad, 1837
Olivella biplicata (Sowerby, 1825)
Littorina planaxis Philippi, 1847
Acmaea spp.

Bryozoa

Bugula sp.

Echinodermata

Dendraster excentricus (Eschscholtz)

Thordata

Amphistichus rhodoterus (Agassiz)
Citharichthys sordidus (Girard)
Citharichthys stigmaeus Jordan and Gilbert
Leptocottus arnatus Girard
Hexagranmos decagranmus (Pallas)

Plankton Found at Drakes Beach Sub-tidal

Zooplankton

1. Nauplius of balanus sp.
2. Cypris of Balanus sp.
3. Larva of a crab
4. Larva of a polychaeta
5. Larva of an amphipod (Hyperia)
6. Noctiluca scintillanus
7. Calanus sp. (Copepod)
8. Favella sp. (Protozoan)

Phytoplankton

1. Chaetoceros sp.
2. Coscinodiscus sp.
3. Thaslassionema sp.

Appendix VI B

Species List for Drakes Beach (Intertidal)

Flora

Zostera marine

Coelenterates

Anthopleura elegantissima (Brandt, 1835)

Annelida

Euzonus mucronata (Treadwell, 1914)
Nephtys californiensis Hartman, 1938
Arabella semimaculata (Moore, 1911)

Anthropoda

Emerita analoga (Stimpson, 1857)
Pachygrapsus crassipes Randall, 1839
Orchestoidea californiana (Brandt, 1851)
Pollicipes polymerus (Sowerby, 1833)
Balanus glandula Darwin, 1854
Cancer magister Dana, 1852
Cirolana harfordi (Lockington, 1877)
Archaeomysis maculata (Holmes)

Mollusca

Siliqua patula (Dixon, 1788)
Olivella biplicata (Sowerby, 1825)
Mytilus edulis Linnaeus, 1758
Acmaea scabra (Gould, 1846)
Littorina planaxis Philippi, 1847

Echinodermata

Dendraster excentricus (Eschscholtz)

Chordata

Citharichthys sordidus

Species list for Chimney Rock (Subtidal)

Algae

Chlorophyta - green algae

Spongomorpha coalita (Ruprecht) Collins

Phaeophyta - brown algae

Pterygophora californica Ruprecht
Nereocystis leutkeana (Mertens) Postels and Ruprecht
Laminaria andersoni Eaton
Cystoseria osmundacea (Menzies) C. A. Agardh
Alaria marginata Postels and Ruprecht
Egregia menziesii (Turner) Areschoug
Desmarestia munda Setchell and Gardner
Coilodesme californica (Ruprecht)
Costaria costata (Turner) Saunders
Lessoniopsis littoralis (Farlow & Setchell) Reinke
Postelsia palmaeformis Ruprecht
macrocystis integrifolia Bory

Rhodophyta - red algae

Iridaea splendens Setchell and Gardner
Porphyra perforata J. G. Agardh
Halosaccion glandiforme (Gmelin) Ruprecht
Gigartina californica J. G. Agardh
Gigartina canaliculata Harvey

Also: Phyllospadix torreyi (Sea grass)

Porifera

Rhabdodermella nuttingi Urban, 1902
Leucosolenia eleanor Urban, 1905
Cliona celata Grant, 1932

Coelenterata

Anthopleura elegantissima (Brandt, 1835)
Anthopleura xanthogrammica (Brandt, 1835)
Epiactis prolifera Verrill, 1869
Aurellia aurita (Linnaeus, 1746)
Corynactis californica Carlgren, 1936
Abietinaria greenei (Murray, 1860)
Aglaophenia latirostris Nutting, 1900
Chrysaora melanaster Brandt, 1838
Polyorchis penicillatus (Eschscholtz, 1829)
Vellella lata

Annelida

Serpula vermicularis Linnaeus, 1767
Eudistylia polymorpha (Johnson, 1901)

Arthropoda

Cancer productus Randall, 1839
Cancer antennarius Stimpson, 1856
Pugettia producta (Randall, 1839)
Balanus glandula Darwin, 1854
Balanus nubilus Darwin, 1854
Pagurus hemphilli (Benedict, 1892)
Pagurus samuelis (Stimpson, 1857)
Idothea resecata (Stimpson, 1857)

Mollusca

Pododesmus macroschisma (Deshayes, 1839)
Tegula brunnea (Philippi, 1848)
Tegula funebralis (Adams, 1854)
Cryptochiton stelleri (Middendorff, 1846)
Haliotis rufescens Swainson, 1822
Haliotis cracherodii Leach, 1817
Hermissenda crassicornis (Eschscholtz, 1831)
Haliotis wallalensis Stearns, 1899
Diaulula sandiegensis (Cooper, 1862)
Anisodoris nobilis (MacFarland, 1905)
Calliostoma ligatum (Gould)
Acmaea paleacea Gould, 1851
Hinnites multirugosus (Gale, 1928)

Bryozoa

Bugula californica Robertson, 1905

Echinodermata

Pisaster ochraceous (Brandt, 1835)
Pisaster brevispinus (Stimpson, 1857)
Pisaster giganteus (Stimpson, 1857)
Pycnopodia helianthoides (Brandt, 1835)
Patiria miniata (Brandt, 1835)
Dermasterias imbricata (Grube, 1857)
Solaster dawsoni Verill, 1878
Leptasterias aequalis (Stimpson, 1862)
Henricia leviuscula (Stimpson, 1857)
Stronglyocentrotus franciscanus (Agassiz)

Echinodermata

Strongylocentrotus pupuratus (Stimpson)
Cucumaria miniata Brandt, 1835
Stichopus californicus (Stimpson, 1857)
Ophiothrix spiculata Le Conte, 1851

Chordata

Styela montereyensis (Dall, 1872)
Amaroucium californicum Ritter and Forsyth, 1917
Amaroucium arenatum Van Name, 1917
Clavelina huntsmani Van Name, 1931

Appendix VIII B

Species list for Chimney Rock (Intertidal)

Algae

Chlorophyta - green algae

Ulva lactuca Linnaeus
Spongomorpha coalita (Ruprecht) Collins

Phaeophyta - brown algae

Costaria costata (Turner) Saunders
Desmarestia munda Setchell and Gardner
Ralfsia pacifica Hollenberg
Egregia menziesii Turner (Areschoung)
Alaria marginata Postels and Ruprecht

Rhodophyta - red algae

Iridaea splendens Setchell and Gardner
Corallina chilensis Decaisne
Microcladia coulteri Harvey
Gigartina canaliculata Harvey
Odonthalia floccosa (Esper) Falkenberg
Gigartina cristata (Setchell) Setchell and Gardner
Prionitis andersonii Eaton

Invertebrates

Coelenterates

Anthopleura elegantissima (Brandt, 1835)
Anthopleura xanthogrammica (Brandt, 1835)
Epiactis prolifera Verill, 1869

Annelida

Glycera americana Leidy, 1855
Sabella media (Bush, 1904)

Arthropoda

Pagurus samuelis (Stimpson, 1857)
Pagurus hirsutiusculus (Dana, 1851)
Pugettia producta (Randall, 1839)
Pycnogonum stearnsi Ives, 1892
Cancer antennarius Stimpson, 1856
Petrolisthes cinctipes (Randall, 1839)
Hapalogaster cavicauda Stimpson, 1859 (1862)
Balanus glandula Darwin, 1854
Idothea resecata (Stimpson, 1857)
Hemigrapsus nudus (Dana, 1851)

Mollusca

Haliotis rufescens
Littorina planaxis Philippi, 1847
Littorina scutulata Gould, 1849
Tegula funebralis (Adams, 1854)
Tegula brunnea (Philippi, 1848)
Acmaea limatula Carpenter, 1864
Acmaea digitalis Eschscholtz, 1833
Acmaea scabra (Gould, 1846)
Acmaea mitra Eschscholtz, 1833
Cryptochiton stelleri (Middendorff, 1846)
Mopalia lignosa (Gould, 1846)
Thais emarginata (Deshayes, 1839)
Pupura foliata Martyn, 1784
Hinnites multirugosus (Gale, 1928)
Tonicella lineata (Wood, 1815)
Thais canaliculata (Duclos, 1832)
Crepidula adunca Sowerby, 1825
Thais lamellosa (Gmelin, 1792)

Echinodermata

Patiria miniata (Brandt, 1835)
Leptasterias aequalis (Stimpson, 1862)
Strongylocentrotus pururatus (Stimpson)
Pycnopodia helianthoides (Brandt, 1835)
Pisaster ochraceous (Brandt, 1835)

Appendix IX A

Species list for Split Rock (Subtidal)

Algae

Chlorophyta - green algae

Spongomorpha coalita (Ruprecht) Collins

Phaeophyta - brown algae

Pterygophora californica Ruprecht
Nereocystis leutkeana (Mertens) Postels and Ruprecht
Laminaria andersonii Eaton
Cystoseria osmundacea (Menzies) C. A. Agardh
Alaria marginata Postels and Ruprecht
Egregia menziesii (Turner) Areschoug
Desmarestia munda Setchell and Gardner
Coilodesme californica (Ruprecht)
Costaria costata (Turner) Saunders
Lessoniopsis littoralis (Farlow & Setchell) Reinke
Postelsia palmaeformis Ruprecht

Rhodophyta - red algae

Iridaea splendens Setchell and Gardner
Porphyra perforata J. G. Agardh
Halosaccion glandiforme (Gmelin) Ruprecht
Gigartina californica J. G. Agardh
Gigartina canaliculata Harvey

Invertebrates

Porifera

Rhabdodermella nuttingi Urban, 1902
Leucosolenia eleanor Urban, 1905
Cliona celata Grant, 1932

Coelenterata

Anthopleura elegantissima (Brandt, 1835)
Anthopleura xanthogrammica (Brandt, 1835)
Epiactis prolifera Verrill, 1869
Aurellia aurita (Linnaeus, 1746)
Corynactis californica Carlgren, 1936
Abietinaria greenei (Murray, 1860)
Aglaophenia latirostris Nutting, 1900

Ctenophora

Pleurobrachia bachei A. Agassiz, 1860

Annelida

Serpula vermicularis Linnaeus, 1767
Eudistylia polymorpha (Johnson, 1901)

Arthropoda

Cancer productus Randall, 1839
Cancer antennarius Stimpson, 1856
Pugettia producta (Randall, 1839)
Balanus glandula Darwin, 1854
Balanus nubilus Darwin, 1854
Pagurus samuelis (Stimpson, 1857)
Pagurus hemphilli (Benedict, 1892)
Idothea resecata (Stimpson, 1857)

Mollusca

Pododesmus macroschisma (Deshayes, 1839)
Tegula brunnea (Philippi, 1848)
Tonicella lineata (Wood, 1815)
Cryptochiton stelleri (Middendorff, 1846)
Haliotis rufescens Swainson, 1822
Hermissenda crassicornis (Eschscholtz, 1831)
Diaulula sandiegensis (Cooper, 1862)
Anisodoris nobilis (MacFarland, 1905)
Calliostoma ligatum (Gould)
Acmaea paleacea Gould, 1851
Hinnites multirugosus (Gale, 1928)

Bryozoa

Bugula californica Robertson, 1905

Echinodermata

Pisaster ochraceous (Brandt, 1835)
Pisaster brevispinus (Stimpson, 1857)
Pisaster giganteus (Stimpson, 1857)
Pycnopodia helianthoides (Brandt, 1835)
Patiria miniata (Brandt, 1835)
Dermasterias imbricata (Grube, 1857)
Leptasterias aequalis (Stimpson, 1862)
Henricia leviuscula (Stimpson, 1857)

Echinodermata

Stronglyocentrotus franciscanus (Agassiz)
Strongylocentrotus pupuratus (Stimpson)
Cucumaria miniata Brandt, 1835
Stichopus californicus (Stimpson, 1857)
Ophiothrix spiculata Le Conte, 1851

Chordata

Styela montereyensis (Dall, 1872)
Amaroucium californicum Ritter and Forsyth, 1917
Amaroucium arenatum Van Name, 1917
Clavelina huntsmani Van Name, 1931
Zalophus californicus

Appendix IX B

Species list for Split Rock (Intertidal)

Algae

Chlorophyta - Green Algae

Spongomorpha coalita (Ruprecht) Collins
Codium fragile (Suringar) Hariot

Phaeophyta - Brown Algae

Egregia menziesii Turner (Areschoung)
Laminaria andersoni Eaton
Alaria marginata Postels and Ruprecht

Rhodophyta - Red Algae

Odonthalia floccosa (Esper) Falkenberg
Corallina chilensis Decaisne
Rhodomela larix (Turner) C. Agardh
Gigartina cristata (Setchell) Stechell and Gardner
Gigartina californica J. G. Agardh

Invertebrates

Platyhelminthes

Leptoplana chloranota (Boone, 1929)

Annelida

Serpula vermicularis Linnaeus, 1767

Arthropoda

Pagurus samuelis (Stimpson, 1857)
Pagurus hemphilli (Benedict, 1892)
Pagurus hirsutiusculus (Dana, 1851)
Idothea resecata (Stimpson, 1857)
Ligia occidentalis Dana, 1853
Pollicipes polymerus (Sowerby, 1833)
Balanus glandula Darwin, 1854
Balanus cariosus (Pallas, 1788)

Cancer antennarius (Stimpson, 1856)
Cancer productus Randall, 1839
Hemigrapsus nudus (Dana, 1851)
Pachygrapsus crassipes Randall, 1839
Pugettia producta (Randall, 1839)
Petrolisthes cinctipes (Randall, 1839)
Pachycheles rudis Stimpson, 1859, (1860)
Hapalogaster cavicauda Stimpson, 1859 (1862)

Mollusca

Mytilus californianus Conrad, 1837
Littorina planaxis Philippi, 1847
Littorina scutulata Gould, 1849
Acmaea persona Eschscholtz, 1833
Acmaea mitra Eschscholtz, 1833
Acmaea digitalis Eschscholtz, 1833
Acmaea scabra (Gould, 1846)
Acmaea pelta Eschscholtz, 1833
Thais emarginata (Deshayes, 1839)
Thais lamellosa (Gmelin, 1792)
Thais canaliculata (Duclos, 1832)
Diodora aspera (Eschscholtz, 1833)
Tegula funebralis (Adams, 1854)
Tegula brunnea (Philippi, 1848)
Mopalia lignosa (Gould, 1846)
Tonicella lineata (Wood, 1815)
Cryptochiton stelleri (Middendorff, 1846)
Haliotis rufescens Swainson, 1822
Octopus sp.

Chordata

Clavelina huntsmani Van Name, 1931

Appendix X A

Species list for Big Pipe Reef (McClures) - (Subtidal)

Algae

Chlorophyta - green algae

Spongomorpha coalita (Ruprecht) Collins

Phaeophyta - brown algae

Pterygophora californica Ruprecht
Nereocystis leutkeana (Mertens) Postels and Ruprecht
Laminaria Andersoni Eaton
Cystoseria osmundacea (Menzies) C.A. Agardh
Alaria marinata Postels and Ruprecht
Egregia menziesii (Turner) Areschoug
Desmarestia munda Setchell and Gardner
Coilodesme californica (Ruprecht)
Costaria costata (Turner) Saunders
Lessoniopsis littoralis (Farlow and Setchell) Reinke
Postelsia palmaeformis Ruprecht

Rhodophyta - red algae

Tridaea splendens Setchell and Gardner
Porphyra perforata J.G. Agardh
Halosaccion glandiforme (Gmelin) Ruprecht
Gigartina californica J.G. Agardh
Gigartina canaliculata Harvey

Also: Phyllospadix torreyi (sea grass)

Porifera

Rhabdodermella nuttingi Urban, 1902
Leucosolenia eleanor Urban, 1905
Cliona celata Grant, 1932

Coelenterata

Anthopleura elegantissima (Brandt, 1835)
Anthopleura xanthogrammica (Brandt, 1835)
Epiactis prolifera Verrill, 1869
Aurellia aurita (Linnaeus, 1746
Corynactis californica Carlgren, 1936
Abietinaria greenei (Murray, 1860)
Aglaophenia latirostris Nutting, 1900

Coelenterata

Chrysaora melanaster Brandt, 1838
Polyorchis penicillatus (Eschscholtz, 1829)

Cenophora

Pleurobrachia bachei A. Agassiz, 1860

Annelida

Serpula vermicularis Linnaeus, 1767
Eudistylia polymorpha (Johnson, 1901)

Arthropoda

Cancer productus Randall, 1839
Cancer antennarius Stimpson, 1856
Pugettia producta (Randall, 1839)
Balanus glandula Darwin, 1854
Balanus nubilus Darwin, 1854
Pagurus hemphilli (Benedict, 1892)
Pagurus samuelis (Stimpson, 1857)
Idothea resecata (Stimpson, 1857)

Mollusca

Pododesmus macroschisma (Deshayes, 1839)
Tegula brunnea (Philippi, 1848)
Tonicella lineata (Wood, 1815)
Cryptochiton stelleri (Middendorff, 1846)
Haliotis rufescens Swainson, 1822
Hermissenda crassicornis (Eschscholtz, 1831)
Diaulula sandiegensis (Cooper, 1862)
Anisodoris nobilis (MacFarland, 1905)
Calliostoma ligatum (Gould)
Acmaea paleacea Gould, 1851
Hinnites multirugosus (Gale, 1928)

Bryozoa

Bugula californica Robertson, 1905

Echinodermata

Pisaster ochraceous (Brandt, 1835)
Pisaster giganteus (Stimpson, 1857)
Pisaster brevispinus (Stimpson, 1857)

Echinodermata

Pycnopodia helianthoides (Brandt, 1835)
Patiria miniata (Brandt, 1835)
Dermasteria imbricata (Brube, 1857)
Leptosterias aequalis (Stimpson, 1862)
Henricia leviuscula (Stimpson, 1857)
Strongylocentrotus purpuratus (Stimpson)
Stronglyocentrotus franciscanus (Agassiz)
Cucumaria miniata Brandt, 1835
Stichopus californicus (Stimpson, 1857)
Solaster dawsoni Verrill, 1878
Ophiothrix spiculata Le Conte, 1851

Chordata

Clavelina huntsmani Van Name, 1931

Appendix X B

Species list for Big Pipe Reef (Intertidal)

Algae

Chlorophyta - green algae

Cladophora trichotoma (C.A. Agardh) Kutzing
Enteromorpha intestinalis (Linnaeus) Link
Ulva lactuca Linnaeus

Phaeophyta - brown algae

Ralfsia pacifica Hollenberg
Egregia menziesii (Turner) Areschoug

Rhodophyta - red algae

Rhodomela
Iridaea splendens Setchell and Gardner
Gigartina canaliculata Harvey
Gigartina cristata Setchell (Setchell and Gardner)
Corallina chilensis Decaisne
Halosaccion glandiforme (Gmelin) Ruprecht
Melobesia marginata
Microcladia borealis Ruprecht

Invertebrates

Coelenterata

Anthopleura xanthogrammica (Brandt, 1835)
Anthopleura elegantissima (Brandt, 1835)
Epiactis prolifera Verill, 1869

Arthropoda

Cancer antennarius Stimpson, 1856
Idothea resecata (Stimpson, 1857)
Pagurus samuelis (Stimpson, 1857)
Pagurus hirsutiusculus (Dana, 1851)
Pugettia producta (Randall, 1839)

Mollusca

Tegula funebralis (Adams, 1854)
Tegula brunnea (Philippi, 1848)
Littorina planixis Philippi, 1847

Acmaea scabra (Gould, 1846)
Acmaea digitalis Eschscholtz, 1833
Balanus glandula Darwin, 1854
Mytilus californianus Conrad, 1837
Haliotis rufescens Swainson, 1822
Mopalia lignosa (Gould, 1846)
Triopha carpenteri (Stearns, 1873)
Ishnochiton mertensii (Middendorff, 1846)
Thais emarginata (Deshayes, 1839)
Acanthina spirata (Blainville, 1832)
Cerithidea californica Haldeman, 1840
Ishnochiton cooperi (Carpenter in Pilsbry, 1892)

Echinodermata

Patiria miniata (Brandt, 1835)
Pisaster ochraceous (Brandt, 1835)
Pycnopodia helianthoides Brandt, 1835
Leptasterias aequalis (Stimpson, 1862)

Chordata

Styela montereyensis (Dall, 1872)

Appendix XI A

Species List for Bird Rock (Sub-tidal)

Algae

Phaeophyta - Brown Algae

Pterygophora californica
Postelsia palmaeformis Ruprecht
Egregia laevigata
Nereocystis luetkeana (Mertens) Postels and Ruprecht
Lessoniopsis littoralis
Laminaria andersonii Eaton
Laminaria farlonii Setchell

Rhodophyta - Red Algae

Gigartina californica J. G. Agardh
Gigartina spinosa
Porifera

Rhabdodermella nuttingi Urban, 1902
Leucosolenia eleanor Urban, 1905
Cliona celata Grant
Aplysiua glacialis (Dybowski, 1880)
Ophlitaspongia pennata (Lambe)
Haliclona permollis (Bowerbank, 1866)

Coelenlerata

Garveia annulata Nutting, 1901
Abietinaria greeni (Murray, 1860)
Cornyactis californica Carlgren, 1936
Epiactis prolifera Verill, 1869
Anthopleura elegantissima (Brandt, 1835)
Anthopleura xanthogrammica (Brandt, 1835)
Aglaophenia latirostris Nutting, 1900
Aurellia aurita (Linnaeus, 1746)

Annelida

Serpula vermicularis Linnaeus, 1767
Eudistylia polymorpha (Johnson, 1901)

Arthropoda

Pugettia producta (Randall, 1839)
Cancer majister
Cancer productus Randall, 1839
Cancer antennarius Stimpson, 1856
Pagurus hemphilli (Benedict, 1892)
Balanus nubilis Darwin, 1854
Balanus glandula Darwin, 1854
Balanus crenatus Bruguiere, 1789
Pagurus samuelis (Stimpson, 1857)
Idothea resecata (Stimpson, 1857)
Pollicipes polymerus (Sowerby, 1833)
Scyra acutifrons Dana, 1852

Mollusca

Haliotis wallalensis Stearns, 1899
Haliotis rufescens Swainson, 1822
Naliotis cracherodii Leach, 1817
Calliostoma ligatum (Martyn, 1784)
Acmaea paleacea Gould, 1851
Tequla brunnea (Philippi, 1848)
Diaulula sandiegensis (Cooper, 1862)
Hernissenda crassicornis (Eschscholtz, 1831)
Anisodoris nobilis (MacFarland, 1905)
Hinnites multirugosus (Gale, 1928)
Tonicella lineata (Wood, 1815)
Cryptiochiton stelleri (Middendorff, 1846)
Pododesmus macroschima (Deshayes, 1839
Mytilus californianus Conrad, 1837

Bryozoa

Bugula sp.

Echinodermata

Pisaster ochraceous (Brandt, 1835)
Pisaster brevispinus (Stimpson, 1857)
Pisaster giganteus (Stimpson, 1857)
Solaster dawsoni Verill, 1878
Henricia leviuscula (Stimpson, 1857)
Pycnopodia Leliarthodies (Brandt, 1835)
Ophiothrix spiculata Le Conte, 1851
Stronglyocentrotus franciscanus (Agassiz)
Strongylocentrotus pupuratus (Stimpson)
Patiria miniata (Brandt, 1835)
Leptasterias aequalis (Stimpson, 1862)
Dermasterias imbricata (Grube, 1857)
Cucumaria miniata Brandt, 1835
Stichopus californicus (Stimpson, 1857)

Chordata

Phoca vitulina
Amourucium californicum Ritter and Forsyth, 1917
Styella montereyensis (Dall, 1872)
Clavelina huntsmani Van Name, 1931

Appendix XI B

Species list for Bird Rock (Intertidal)

Algae

Chlorophyta - green algae

Spongomorpha coalita (Ruprecht) Collins
Ulva lactuca Linnaeus
Enteromorpha compressa (Linneaus) Greville
Cladophora trichotoma (C.A. Agardh) Kutzing

Rhodophyta - red algae

Corallina chilensis Decaisne
Gigartina cristata (Setchell) Setchell and Gardner
Gigartina canaliculata Harvey
Gigartina californica J. G. Agardh
Endocladia muricata (Postels & Ruprecht) J. G. Agardh
Porphyra perforata J. G. Agardh
Halosaccion glandiforme (Gmelin) Ruprecht
Iridaea splendens
Gastroclonium coulteri (Harvey) Kylin
Prionitis lanceolata Harvey

Phaeophyta - brown algae

Ralfsia pacifica Hollenberg
Egregia menziesii (Turner) Areschaug
Pelvetia fastigata (J. G. Agardh) DeToni

Porifera

Leucosolenia eleanor Urban, 1905
Plocamia karykina de Laub, 1927

Coelenterata

Anthopleura xanthogrammica (Brandt, 1835)
Epiactis prolifera Verrill, 1869

Arthropoda

Trigriopus californicus (Baker, 1912)
Balanus glandula Darwin, 1854
Pollicipes polymerus (Sowerby, 1833)
Idothea stenops (Benedict, 1898)
Cander antennarius Stimpson, 1856
Pachygrapsus crassipes Randall, 1839
Pugettia producta (Randall, 1839)

Arthropoda

Pagurus hirsutiusculus (Dana, 1851)
Pagurus samuelis (Stimpson, 1857)
Petrolisthes cinctipes (Randall, 1839)
Pycnogonum stearnsi Ives, 1892

Mollusca

Mopalia lignosa (Gould, 1846)
Tonicella lineata (Wood, 1815)
Mytilus californianus Conrad, 1837
Diodora aspera (Eschscholtz, 1833)
Acmaea digitalis Eschscholtz, 1833
Acmaea scabra (Gould,1846)
Acmaea pelta Eschscholtz, 1833
Acmaea limatula Carpenter, 1864
Tegula funebrallis (Adams, 1854)
Littorina planaxis Philippi, 1847
Littorina scutulata Gould, 1849
Thais emarginata (Deshayes, 1839)
Hermissenda crassicornis (Eschscholtz, 1831)

Echinodermata

Dermasterias imbricata (Grube, 1857)
Pisaster ochraceus (Brandt, 1835)
Patiria miniata (Brandt, 1835)
Cucumaria curata (Cowles, 1907)
Strongylocentrotus purpuratus (Stimpson)

Choradata

Clavelina huntsmani Van Dame, 1931